

From Agriculture to Nutrition

Pathways, Synergies, and Outcomes

Agriculture and Rural Development Department
World Bank



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CONTENTS

Acronyms and Abbreviations	v
Acknowledgements	vi
EXECUTIVE SUMMARY	vii
1: INTRODUCTION	1
World Food Security And Nutrition Situation	2
Child Nutrition	3
Micronutrient deficiencies	4
Overweight, obesity and diet-related chronic diseases	5
2: DETERMINANTS OF HUMAN NUTRITION AND THE PATHWAYS LINKING	
AGRICULTURE AND NUTRITION	8
3: THE IMPACT OF AGRICULTURE INTERVENTIONS ON NUTRITION OUTCOMES	15
The Nutritional Impacts of Agricultural Interventions	16
Gender Outcomes Of Agricultural Interventions	31
Summary	32
4: CASE STUDIES	35
Orange-fleshed sweet potato production and vitamin A deficiency in Kenya and	
Mozambique	35
Legume systems and child nutrition in Malawi	38
Integrating homestead gardening and primary health care activities in South Africa	40
Homestead Gardening for fruits, vegetables and livestock in Asia	42
Lessons from the Four Case Studies.....	46
5: THE CHANGING CONTEXT OF AGRICULTURE and NUTRITION.....	47
Agricultural policy	47
Agricultural technology	51
Food marketing systems.....	56
food consumption patterns.....	61
6: INSTITUTIONAL FRAMEWORKS FOR ACTION IN THE AGRICULTURE SECTOR TO	
ADDRESS UNDERNUTRITION.....	65
Institutional barriers to coordinated action in nutrition	66
Resource allocation and planning.....	67
Sector mandates and priorities	68
Unique sectoral worldviews	69
Constrained capacity for nutritional analysis	69
Institutional mechanisms to enable agriculturalists to address undernutrition	70
Conclusions.....	74
CHAPTER 7: CONCLUSIONS AND NEXT STEPS.....	76
Appendix.....	80
Methodology used in Chapter 3 (staples)	80
References.....	83

Figures

Figure 1: Estimated prevalence of stunted preschool children 1980-2005	3
Figure 2: Estimated prevalence of underweight preschool children 1980-2005	4
Figure 3: Overweight and obesity among women aged 45-59 years, by WHO region	6
Figure 4: Estimated Prevalence of Overweight Preschool Children (%).....	7
Figure 5: Conceptual Framework of the Determinants of Nutritional Status	8
Figure 6: Potential Impact of Technological Changes on Food Production and Consumption	52
Figure 7: Changes in Food Production Per Capita over Time	53

Tables

Table 1: Prevalence and number of undernourished people in developing countries 1990-2003	2
Table 2: Key results from selected studies of agricultural commercialization	18
Table 3: Summary of the evaluation findings of horticultural and nutrition projects	22
Table 4: Summary of Intervention Studies on Impacts of Animal Source Food Interventions on Nutrition-related Outcomes	27
Table 5: The growth of modern retail in developing countries.....	59
Table 6: Composition of Global Agricultural Exports (% of value).....	60
Table 7: Average Annual Growth in Global Per Capita Consumption of Various Food Items (%).....	61
Table 8: Average Annual Share of Arable and Permanent Land Used for Harvest (%).....	63
Table 9: Worldwide Annual Average Growth in Food Production (%)	63

Boxes

Box 1: Key Messages from Publications on Agriculture and Nutrition, 1970s-2000s	10
Box 2: Introducing Orange-fleshed Sweet Potato in Rural Mozambique.....	36
Box 3: Legume Systems in Malawi: Building on Local Knowledge, Improving Nutrition	40
Box 4: Trade Liberalization and Food Consumption: Synthesis of Cases in South Asia.....	49
Box 5: Decline in Consumption of Pulses in India: The Effect of Technology and Domestic Policies	54
Box 6: Modern Marketing Channels and Food Prices	57
Box 7: Situating Nutrition Administratively within the Public Sector	66
Box 8: The Institutional Study under The Agriculture-Nutrition Advantage project	67
Box 9: Nutrition and Sector-Wide Approaches to Planning	68
Box 10: Home Economists as Agricultural Extension Agents	73

ACRONYMS AND ABBREVIATIONS

AVRDC	Asian Vegetable Research and Development Center
BMI	Body Mass Index
CDD	Community-Driven Development
FAO	Food and Agriculture Organisation (United Nations)
FRT	Farmer Research Team
HACCP	Hazard Analysis Critical Control Point
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HKI	Helen Keller International
IDRC	International Development Research Center
IFPRI	International Food Policy Research Institute
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
OFSP	Orange-Fleshed Sweet Potato
SETSAN	Technical Secretariat for Food Security and Nutrition (Mozambique)
SFHC	Soils, Food and Health Communities Study (Malawi)
SWAp	Sector-Wide Approach
TANA	The Agriculture-Nutrition Advantage project
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VITAA	Vitamin A for Africa
VITAL	Vitamin A Field Support project
WFSP	White-Fleshed Sweet Potato
WHO	World Health Organization
WTO	World Trade Organization

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EXECUTIVE SUMMARY

Introduction

In a world abundant with food, hundreds of millions of people face a range of nutritional problems. In some parts of the world, the poor have inadequate access to energy (measured in calories) from food. In these locations, food shortages are often seasonal phenomena, and the quantitative deficit of food energy is generally matched by deficits in food quality reflected in insufficient essential micronutrients such as vitamin A, iron, zinc, folate, and a variety of phytochemicals. Elsewhere consumption among the poor is characterized by monotonous diets in which these micronutrient deficiencies are found despite stable and sufficient intakes of food energy. Still other places see a “nutrition transition” underway in which diets are characterized by excessive intakes of energy, largely from fat, added sugars and energy-dense processed foods, and in which lifestyles are characterized by generally low levels of physical activity. This combination of excessive energy intake and low activity patterns is associated with overweight and obesity, and a variety of chronic diseases including diabetes and heart disease. Together these adverse nutrition outcomes affect some 2 billion people worldwide.

The relationship between agriculture and human nutrition, or from food production to food consumption is intuitively direct, but in practice is quite complex. Increased food production should lead to greater food availability, access, and ultimately improved food intake and diets. Yet the persistence of malnutrition as a global public health concern despite the successes in increasing agricultural production belies any notion that malnutrition and undernutrition can be solved entirely from the supply side by increasing agricultural production. The question of how agriculture can more effectively contribute to improved nutrition outcomes therefore requires an answer that encompasses factors other than food supply, and that takes into account other sectors in addition to agriculture that contribute to nutrition. The human development sectors in particular, education as well as health, address nutrition in terms of its essential role in building and maintaining human capital. The interface between agriculture and human development provides a far more complete picture of nutrition that relates supply to demand and production to consumption.

In terms of nutrition outcomes, the limitations of production-focused agricultural programs and interventions have long been recognized, and finding ways to maximize the potential impact of agriculture on nutrition has been an increasing priority for some within the agricultural community for decades. In the early 1980s a number of international development agencies undertook programs that sought to orient agricultural production to nutrition-related objectives, but with generally mixed results. The emergence of biofortification as a large-scale joint agricultural-nutrition initiative took well over a decade to come to fruition. Over time, a substantial body of literature developed around the nutritional impacts of agriculture programs, and how agricultural investments could be designed and targeted to maximize these impacts, but with frustratingly few results of practical use for policymakers or analysts. The magnitude and scope of persistent malnutrition and the continued need to invest in agriculture warrants more analytical work to guide agricultural investments and strategies needed in achieving improved nutritional outcomes. This is the rationale for undertaking this study.

Objective

Analyzing what has been learned about how agriculture influences nutritional outcomes in low and middle income countries, and the institutional structures which come into play to influence this relationship is the purpose of this economic and sector work. The report presents a review, and where possible, a synthesis of available evidence on the impacts of agricultural development on human nutrition. It also reviews and synthesizes lessons learned from institutional, organizational, and political endeavors to improve the synergies between food production and food consumption in ways that upgrade the health and nutritional aspects of consumption. It identifies the most critical emerging opportunities and challenges for increasing the nutritional impacts of agricultural production and innovation. Finally the report assesses some of the practical implications of recent findings which have particular significance for agriculture programs that propose to improve nutrition outcomes in lower and middle income countries. The producers and consumers of principal concern to this analysis are those living on less than a dollar a day – those who are the focus of the Millennium Development Goals.

Pathways Linking Agriculture to Nutrition

The widely used conceptual framework developed by UNICEF identifies three main underlying determinants of nutritional status: availability and access to food; optimal quality of feeding and caring practices; and a healthy environment and adequate access to health care services. Each of these pathways is necessary, but insufficient in itself, to ensure good nutrition. Agriculture is likely to improve nutrition mainly through the food production pathway, but can also contribute to the other two pathways through increased income and women's empowerment. The pathways linking food production with food consumption and human nutrition along the food supply chain can be usefully captured in terms of five *pathways*:

- Subsistence-oriented production for the household's own consumption
- Income-oriented production for sale in markets
- The reduction in real food prices associated with increased agricultural production
- The empowerment of women as agents instrumental to household food security and health outcomes
- The indirect relationship between increasing agricultural productivity and nutrition outcomes through the agriculture sector's contribution to national income and macroeconomic growth

The pathways are archetypal; representing model forms which in reality are by no means self-contained or mutually exclusive. Subsistence production for instance generally takes place alongside production for sale since few households are self-sufficient in food, and since food is not the only requirement that must be met. Income is therefore very important even among households that produce principally for their own consumption. The income and price pathways are likewise overlapping in that the price reductions resulting from increased food supply are given in real terms and as such serve to raise real income.

Household production for the household's own consumption is the most fundamental and direct pathway by which increased production translates into greater food availability and food security. The different types of foods produced determine the impact of the production increase on diet quality. The production of more staples leads to mainly quantitative increases in energy intakes. Increased production of fruit, vegetables, dairy foods, eggs, fish, and meat can likewise

raise macronutrient intakes, but with greater impacts on micronutrient intakes that can close dietary gaps in essential nutrients like iron, zinc and vitamin A. These more micronutrient-rich food sources can also make staple foods more palatable, and lead to higher still energy intake. Animal source foods in particular are energy- and protein-dense. Given favorable intra-household processes of food distribution, these developments can greatly improve the food intake and nutrition of the more vulnerable members of the household. The household itself in this scenario is a net producer of food, and the surplus food produced can be sold to market once much or most of the households' own food requirements are satisfied. In this pathway the household's endowment of productive resources—land, labor, and capital—is the prime determinant of the nutritional status of its members. The income derived from the sale of the surplus produced plays an important but generally supplemental role in determining nutrition outcomes in this scenario.

Income-oriented production for sale in markets. Increasing market orientation brings a second pathway into play, one in which the relative importance of subsistence-related production and income-related production switch. Income now becomes the principal determinant of nutrition outcomes and household production for own consumption assumes a supplementary role. Technology becomes more important relative to the household's resource endowment, and the selection of crops to be grown is based principally on their tradability and the price they are expected to command in local markets. In diversifying rural economies that are experiencing growth in sectors beside agriculture, markets may expand well beyond local communities and transport and post-harvest technologies permitting, may even find buyers in international markets. The same technologies that enable export also enable import, and the variety of food sources available to consumers is likely to expand, making possible more complex and higher quality diets. Intensification of staple food production, and opportunities for livestock, fish and fruit and vegetable production, can also generate employment for landless or land-poor individuals. Increases in income can of course be used for purposes other than and in addition to household food security, but the share that is used to purchase foods can have a variety of nutritional effects. Extra income may be used to buy more food, or to buy higher quality food that increases the consumption of micronutrients without raising caloric intakes at all.

Lowering food retail prices by increasing food production is the third pathway linking agriculture to nutrition. Raising production may reduce food prices especially in areas where markets are less integrated. For net consumers, reduced food prices enable greater access to food, and greater intakes of food and nutrients that allow them to meet their daily nutrient requirements, resulting in better livelihoods for the general work force while also freeing up additional household resources from food to other expenditures, including productive investments. In addition, if prices of fruits and vegetables decline, net consumers can potentially benefit not just through the reduction of risk for micronutrients deficiency, but also reduce the risks of chronic diseases such as cardiovascular diseases and diabetes.

The empowerment of women is a pathway that carries special significance for household nutrition outcomes, and in particular for outcomes among the most vulnerable members of the household. Research in Africa, Asia, and Latin America has consistently found women to be more likely than men to invest in their children's health and nutrition, and the income and resources that women control wield disproportionately strong effects on health outcomes generally. Women who are reached by agricultural programs that relay information on nutrition issues appear to be particularly effective in delivering improved nutrition outcomes. The positive effects of increases

in women's income on childhood nutrition appear most pronounced among the lowest income groups. Taken together, these characteristics make women natural priorities for virtually any agricultural program or intervention with nutrition-related objectives. Women are without question prime agents of household food security, but they are generally also time- and resource-constrained agents, and especially in rural contexts. Classifications of the roles they play, from child- and elder-care to food production to food preparation to water collection to a variety of income-generating activities reveal a picture of people under excruciating pressure. Agricultural programs that seek to capitalize on women's profound importance to nutrition outcomes must take women's time and resource constraints firmly into account, and where and when possible, seek means of relieving them.

Finally, *agricultural growth* itself represents an indirect pathway through its contribution to macroeconomic growth and higher levels of national income which can support nutritional improvements by reducing poverty. Increases in agricultural productivity have been vital factors in building sustained economic growth in both developed and developing countries, and with major impacts on poverty. A recent cross-country analysis found that, at the national level, a 1 percent increase in agricultural yields lowers the percentage of population living on less than \$1 per day by between 0.64 and 0.91 percent – a poverty effect that appears particularly great in African countries (World Bank 2006). Overall, however, the economic growth to malnutrition relationship is modest. A doubling of gross national product (GNP) per capita in developing countries has been associated with a much more modest reduction in childhood undernutrition – in the order of only 23 to 32 percent (Haddad et al. 2003).

Agricultural Programs with Nutrition-Related Objectives

The potential of agricultural programs to contribute to improved nutrition outcomes through the set of pathways described above is theoretically sound, but most of the empirical evidence linking agriculture and nutrition comes from studies documenting the first three pathways, that is production, income, and women's empowerment. The literature reviewed can be usefully classified by commodity type: staples, fruits and vegetables, and animal source foods, including dairy and fish products.

Literature that reviews the nutritional impacts of programs involving staple crops like maize and rice was seriously limited by available evidence, which focused overwhelmingly on aggregate production and food availability rather than on individual or household level indicators of nutritional impacts. Moreover, the only agricultural interventions involving staple foods that have been evaluated from a nutritional perspective concern agricultural commercialization – the conversion from staple subsistence food production to commercial food production. This type of intervention aims to improve nutritional outcomes through both the own-consumption and the income pathways, with potential indirect impacts through the agricultural growth and price pathways. Evidence from the review of studies on agricultural commercialization shows increases in household income, including greater income controlled by women in some cases, and greater household food expenditure. This, however, did not consistently translate into greater energy intakes, as households shifted to more expensive sources of energy and possibly greater dietary diversity. In terms of nutritional benefits, the studies showed no impact – either positive or negative – on childhood nutrition. The main lesson learned from this set of studies is that although agriculture morbidity or nutritional status. Most programs related to commercialization of staple food production carried an implicit assumption that increased household income would naturally lead to improved nutrition outcomes. Evidence did point to increased food expenditure

resulting from higher incomes, and possibly to more diversified diets, which is generally a sign of improved overall diet quality. Ultimately the studies would suggest that agricultural interventions that promote commercialization may effectively increase household income and food security, these benefits do not translate automatically in improved childhood nutrition. It is likely that for these interventions to improve childhood nutrition, they would need to be complemented by approaches that specifically target other determinants of child nutrition such as improved health and care-giving practices.

Agricultural interventions promoting increased production of fruit and vegetables carry considerable potential for addressing micronutrient deficiencies. Those that have been evaluated from a nutrition perspective have thus far been homestead gardens, and a number of these programs have had explicit nutrition-related goals. The review concluded that there was a significant body of evidence on the success of homestead gardens in raising production, income, household consumption and intake of targeted fruit and vegetables by vulnerable population groups. Several programs also showed significant impacts on dietary and biochemical indicators of micronutrient deficiencies, and especially so if they included a strong education and behavior change component and women's empowerment interventions.

Programs and interventions targeting involving animal source food products carry have even greater potential to tackle micronutrient deficiencies, especially vitamin A, iron and zinc deficiencies, because these micronutrients are more readily bio-available (i.e. easier to absorb and use) in animal source foods compared to plant foods. Again, several interventions showed gains in production, income and household food security, and address micronutrient deficiency given the higher bio-availability of the nutrients they contain. Again, generally mixed results assumed significantly greater nutrition impacts when combined with interventions focusing on components involving women, information, and education and behavior change. .

Four case studies of agricultural interventions were reviewed because of their unique contribution to the body of knowledge on linkages between agriculture and nutrition. They include an orange-fleshed sweet potato intervention to improve vitamin A in Kenya and Mozambique, a legume systems and child nutrition program in Malawi, a homestead gardening project integrated with primary health care activities in South Africa, and an integrated homestead gardening and livestock program in Asia. All four programs achieved their ultimate objective of improving the intake of focus nutrient-rich foods by target population groups, and the two studies that measured biochemical indicators showed reductions in vitamin A deficiency. Common elements that appear to have contributed to the success of these four programs include the strong behavior change component, the careful consideration of local contexts, the focus on building partnerships with different members of the communities to promote ownership, and the specific focus on women's empowerment. The studies also reaffirm that careful evaluation design is critical but remains a challenge, as does scaling up of successful pilot programs.

Overall the review documents a wide-range of successful agricultural interventions that have contributed to improved nutrition outcomes. In most cases, however, the exact pathways by which impacts on nutrition have been achieved are difficult to track. This is because studies document impacts on several intermediary outcomes such as food security, income, or women's empowerment, but without directly modeling these pathways of impact to nutrition outcomes. Because these outcomes are so closely intertwined, it is impossible to determine from this literature the relative importance of the different pathways linking agriculture and nutrition.

Drivers of a Changing Agriculture-Nutrition Context

Over time, changes in the global environment have been modifying how agriculture impacts nutrition. The developments bear heavily on the pathways linking production and consumption, and the quality of diets.

Agricultural technology, once focused overwhelmingly on varietal improvements to achieve yield increases, now carries significance for every niche of the food production, supply, and consumption chain. The public agricultural research and plant breeding elements of the Green Revolution have maintained their importance, but now alongside the mounting presence of private sector, profit-oriented research – a development that has opened entire new legal realities around intellectual property rights. Agricultural technology is extremely important for the relative prices of different food baskets, for labor demand among different agricultural production systems and at different stages of development, and for the variety of foods available to consumers. Its direct applications to nutrition outcomes relate to both plant breeding for nutrient content and to fortification during food processing. It has had important implications for food safety as well, equipping regulatory agencies with new means of detecting food contaminants and improving the shelf life of processed food products. Non-agricultural technologies like refrigeration and secure transport systems have played a scarcely less important role in increasing the economic availability of food and across whole new spatial magnitudes of geography, facilitating an extraordinary expansion of international food trade.

Agricultural policy. International trade brings agricultural policy firmly into this treatment. Trade has tremendous importance for food producers and food consumers. The macroeconomic impacts of trade liberalization on food prices are contingent on whether a country is a net food producer-exporter, or a net food consumer-importer, but more meaningful indicators are usually commodity-specific. The impact of liberalization on food producers tends to depend on whether a country's agriculture sector was initially protected or taxed in the period before the liberalization was introduced. Its impacts on nutrition outcomes tend to rely broadly on a country's level of economic development. Least developed countries with protected agriculture sectors appear to have the least ability to capitalize on or respond to opportunities on the international markets, and nutrition outcomes often see negative impacts from trade reform.

Trade liberalization emerged out of previous contexts of trade protectionism, and these were mirrored in large measure by interventionist domestic agricultural policies in developing countries during the post-colonial period. Domestic agricultural policies traditionally assumed similarly interventionist approaches in developing countries, and very often with a bias against agriculture which taxed the “backward” agriculture sector to subsidize the more “forward” urban and industrial sectors and to finance import substitution.

Changing consumption patterns. The demand for higher value, micronutrient rich foods increases as incomes rise and livelihoods diversify around expanding markets, many of them urban. Increasing incomes and urbanization drive changes in demand that provide food suppliers with market signals that tend to reorient agricultural production away from the cultivation of staples and toward higher value products. For smallholders in particular this reorientation is often in effect compulsory, since the viability of farming lower value staple crops relies on much larger scales of production than are possible on small farms. For food consumers, and especially net food consumers, the shift in consumption away from staples and toward higher value food sources brings a phenomenon that is generically referred to as the “nutrition transition.” The

phenomenon is most pronounced in rapidly growing economies and in urban areas, where the proportion of food prepared at home declines in relation to the proportion of processed foods consumed at and outside the home. Diets tend to become increasingly energy-dense, and very often excessively so at the same time that automation, transportation and sedentary lifestyles dramatically reducing the level of physical activity and thus energy requirements. Negative outcomes like obesity, heart disease, and diabetes quickly become endemic, which in turn prompts additional changes in the demand for food. Functional foods that carry health benefits become the focus of advertising and the communication of health-related information, with dramatic effects on the types of foods that are demanded. The trend offers a variety of important opportunities for producers who are able to respond to the changing demand. As consumers manifest greater willingness to pay more for healthier foods, responsive producers find a very real prospect that the downward pressure on prices exerted by increased production may be reversed. However promising this prospect may be, the ability of poor producers to capitalize on the emerging opportunities is contingent on a number of factors, not the least of which is the risk of converting to the cultivation of unfamiliar crops. In the final analysis, much will depend on the success of arrangements like contract farming, which enable poor farmers to link their production with large, often supermarket-led supply chains.

Food Marketing Systems. The past two decades have seen a major transformation and consolidation of food retail, and an expansion of the food processing and food service industries, especially in middle income countries and urban areas of low income countries. These trends are being driven by such factors as rising household incomes, urbanization, improvements in transportation, life-style changes, and liberalized foreign investment regulations. Food processing, food retail, and food services are increasingly influencing the basket of food items available for consumption as more and more people work farther from home and are more likely to purchase meals prepared outside the house. The food services industry is also influencing what is being produced by farmers around the world through its very extensive networks of suppliers. While this has moderating effects on the price of food items, it is raising concerns over the ability of small producers in developing countries to benefit from expanding and integrating food supply chains. The challenge for policy makers is how best to take the advantages of globalization while minimizing the negative impacts on small producers.

Institutions

Increasing food supply or food availability is sectoral in scope but improving nutritional outcomes is a decidedly inter-sectoral goal. For substantial, country-wide nutrition outcomes to be realized, the types of small-scale agricultural interventions treated in this report need to be scaled up and successes replicated across whole categories of producers and consumers. The determinants of nutritional outcomes involve many players, including households and public and private sector agents. These determinants extend upward to institutions, *government* institutions that formulate public policy and that in so doing influence the settings in which agricultural-nutrition pathways are or are not operationalized. Jurisdiction over food production is generally assigned to a country's ministry of agriculture. Nutrition on the other hand is not ordinarily considered a sector. Nutrition is an issue that straddles multiple sectors and does not fall firmly within the jurisdiction of any particular government ministry or agency, not even health ministries. Health ministries generally assume the most direct responsibility for nutrition, but have no administrative jurisdiction or influence over agriculture or trade – the most important sector ministries to food supply and availability. Common sense is likely to suggest the

establishment of a multi-sectoral governmental agency to coordinate joint action among these ministries. Yet the resounding lack of successful multi-sectoral coordinating bodies leaves little empirical basis for assuming that such institutional adaptations are likely to work in the future. Concerted programmatic coordination between different ministerial-level institutions tends to run headlong into the bureaucratic barriers that divide spheres of responsibility between different line ministries. Bureaucracies in general are organized to rationally divide responsibilities, not to orchestrate joint collaboration between administrative divisions. Coordination between different government institutions is therefore problematical, but cannot be categorically dismissed. Possibilities for such collaboration are by no means limited to systematic high-level institutional frameworks governed by a regular vested government agency. More limited, lower-level opportunities for collaboration over specific issues appears to be a more promising focus of exchange between sectors. This level of collaboration may improve coordination gradually, in discrete increments that cumulatively lead to government line ministries coordinating certain activities around select issues.

Conclusions

Policy makers and practitioners have long aimed to influence nutritional outcomes through agricultural programs. Many of these programs supported commercialization and cash crop production and boosted production of fruits and vegetables, or animal source foods with income-related objectives. The assumption was that agriculture would address protein-energy deficiency by increasing food production and lowering food prices. While production increased, protein energy malnutrition persisted and increased income resulting from commercial agriculture did not substantially improve child nutritional status. The persistence of child malnutrition despite increased production and income led to the conclusion that increasing agricultural production and income were probably necessary but clearly not sufficient conditions to solving malnutrition. When such agricultural programs were complemented with interventions addressing other determinants of child nutrition like maternal health seeking and care-giving practices, the impacts on household nutrition outcomes, and those of children in particular improved significantly.

Agricultural programs and policies that empower women and involve them in all phases of program activities also have greater impact on health and nutrition outcomes. The essential role of women in delivering health and nutrition outcomes makes gender an inevitable priority area for agricultural programs and policies that seek to contribute to nutrition. Targeting women in their roles as economic agents and stewards of household food security and health generally entails increasing their access to productive resources and services – an ostensibly straightforward proposition which in reality must take into account and purposefully navigate around a variety of women's constraints, including cultural constraints. The significance of women's education to the health and nutrition of their children is an established axiom of development planning. This education by no means has to be limited to formal education. Communication of information about health issues like appropriate child feeding and care practices, water sanitation, and food safety issues carry great importance for nutrition by addressing care-giving and health as necessary conditions of good nutrition. Other public information services, including those agricultural extension services that convey information about issues like integrated pest management likewise have important positive health impacts, and can also be tailored to reach women.

Nutrition is intrinsically multi-sectoral, and increasing agriculture's impacts on nutrition outcomes necessarily entails improving the interface between agriculture and other sectors that bear on nutrition, including health, education, and trade. Improving the collaboration among these government institutions is an imperative, however there has been limited (or even lacking altogether) successful precedents for inter-agency coordination. The paper documents the lack of successful examples of bureaucratic and professional barriers to effective joint action between government institutions, and explores a variety of possible inroads which do not require broad programmatic coordination. The inroads which appear most promising are more opportunistic and incremental in scope and may find intermittent openings in institution's common service to broader national development strategies, in which nutrition is generally included among priority policy areas.

1: INTRODUCTION

In a world of food abundance, millions of people suffer from poor nutrition. In some parts of the world, the poor have inadequate access to energy from food to meet their energy requirements. In these locations, food shortage is often a seasonal phenomenon and micronutrients are also generally lacking in the diet. Elsewhere, there is a stable supply of energy but the poor have monotonous diets lacking in essential micronutrients. In other places a “nutrition transition” is underway in which the poor and other consumers enjoy sufficient access to energy, and indeed often consume excessive amounts, but the quality of their diets is unhealthy owing to a combination of factors relating to nutrition and lifestyle. A combination of these nutritional problems adversely affects around 2 billion people worldwide.

Human nutrition can be addressed through a variety of strategies. The factors that contribute to malnutrition and poor nutrition outcomes are complex, and vary across production and consumption settings. Sector-specific strategies tend to approach nutrition issues along narrowly disciplinary lines and generally fail to capture contributing factors which fall outside the purview of that particular field. Nutrition is an intrinsically multi-sector, multi-disciplinary issue and strategies that seek to improve nutrition outcomes require purposefully multi-sectoral approaches that achieve effective interface between academic and professional domains. The significance of agriculture to this interface, given its role as the source of food production, is clear. Yet understanding how agricultural intervention can best improve nutrition outcomes remains a challenge for policymakers and analysts concerned with achieving improved nutrition. Multi-sector efforts intended to simultaneously address agriculture and nutrition have often been hindered by institutional barriers and insufficient resources, and are treated in chapter 6.

Agricultural investments and interventions supported by the World Bank and other international development and donor agencies have seldom explicitly incorporated nutrition-related objectives. The World Bank itself last examined this issue in 1981 in a study by Per Pinstrup-Andersen, and a recent review of its agriculture and rural development portfolio revealed little or no lending for nutrition issues to be included in agricultural education or extension services. Only recently has the still-developing approach of biofortification provided a notable exception to this omission.

The contexts in which agriculture and nutrition are linked have moreover changed over time (Hawkes and Ruel 2006). The focus of nutrition as a development issue, and a human development issue in particular, has expanded from an early emphasis on energy-protein deficiency to include micronutrient deficiencies, and more recently extends to the relationship between excess energy intake, poor quality diets, obesity, and chronic diseases. The agricultural context itself is also changing. Although 75 percent of the world’s poor still live in rural areas with poor access to markets and services, fewer people are now dependent on agriculture for their livelihoods and more are connected to markets. The percentage of poor people who live in urban areas in developing countries is growing. Urbanization reflects a migration away from rural, agriculture-based employment, and into urban livelihoods. People in cities are less likely to experience undernutrition and more likely to experience the “nutrition transition” towards energy-dense diets high in fats, sweeteners and highly-refined carbohydrates (Popkin 1999). Overall, the processes of global market integration or “globalization” have increased the market-orientation of the

agri-food system worldwide, unleashing dynamics throughout the food supply chain that affect food producers and consumers.

Malnutrition remains an urgent global public health concern. The question of how agriculture can most effectively contribute to improved nutrition outcomes remains unanswered. It is therefore time to revisit what is known, and what can be done, to improve the synergies between agriculture and nutrition. The potential contribution of agriculture needs to be re-examined, especially in light of the changes the sector has undergone, by reviewing lessons from past experience and by analyzing current developments and what they mean for future change. This is the purpose of this report.

More specifically the report seeks to analyze what has been learned about how agricultural interventions influence nutrition outcomes in low and middle income countries, focusing on the target populations of the Millennium Development Goals – people living on less than a dollar a day. It also sets out to synthesize lessons from past institutional and organizational efforts to improve the synergies between agriculture and nutrition outcomes. The report identifies a number of developments in agriculture and nutrition which have transformed the context in which nutrition outcomes play out, and with considerable practical significance for nutrition-related agricultural programs – including the design of those programs that aim to improve nutritional outcomes. Finally the account leads to a number of practical conclusions that shed light on how agricultural interventions and investments may improve nutrition outcomes in low and middle income countries.

WORLD FOOD SECURITY AND NUTRITION SITUATION

The Food and Agricultural Organization (FAO) estimates that in 2000-03, 854 million people worldwide were undernourished, as defined by food intakes that are continuously inadequate to meet dietary energy requirements (FAO 2006). The number included 820 million people in developing countries, 25 million in transition countries, and 9 million in industrialized countries. In developing countries, this represents a decline of only 3 million people since 1990-92. And while significant progress has been achieved in Asia, the number of undernourished people in Africa has been increasing as shown in table 1.

Table 1: Prevalence and number of undernourished people in developing countries 1990-2003

FAO Region	Prevalence of undernourished (%) ^a		Number undernourished (million)	
	1990/92	2001/03	1990/92	2001/03
Developing countries	20	17	823.1	820.2
Sub-Saharan Africa	35	32	169.0	206.2
Near East & North Africa	8	9	25.0	37.6
Asia	20	6	569.7	524.0
Latin America / Caribbean	13	10	59.6	52.4

Source: (FAO 2006)

^a Undernourishment is defined as food intake that is continuously inadequate to meet dietary energy requirements

Undernourishment here is defined as food intake that is continuously inadequate to meet dietary energy requirements. The broader concept of food security necessarily goes beyond the satisfaction of people's energy requirements through sufficient intakes to encompass access to "sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life" (World Food Summit 1996). A summary of the nutritional situation in the world is presented here in three categories: childhood

undernutrition, micronutrient deficiencies, and overweight and obesity and related chronic diseases. More complete analyses of these trends are available in the 2006 World Bank report *Repositioning Nutrition for Development*, and in the fourth and fifth reports on the World Nutrition Situation issued by the United Nations Standing Committee on Nutrition in 2000 and 2004.

CHILD NUTRITION

It is well recognized that the most nutritionally vulnerable population groups are pregnant and lactating women whose bodies must cope with the additional nutritional stresses and demands of pregnancy and lactation, and infants and young children up to age two. The present report addresses these vulnerable groups, but with a greater emphasis on children's nutrition because most of the work linking agriculture and nutrition to date has focused on this age group. Childhood undernutrition is typically reflected in anthropometric indicators like stunting (low height-for-age), wasting (low weight-for-height), and underweight (low weight-for-age). Stunting reflects the cumulative effects of inadequate nutrition, while wasting reflects more recent or acute weight loss. These symptoms are non-specific and reflect a combination of nutritional deficiencies including protein, energy and/or micronutrients. They may be seasonal or chronic. Dietary shortages of Vitamin A, iodine, iron, and zinc are the most widespread micronutrient deficiencies and disproportionately affect women and young children.

Childhood undernutrition has dropped globally from 1980 to 2005. Stunting now affects approximately one third of all children in the developing world, compared to one half in 1980. The proportion of underweight children fell from 38 to 25 percent during the same period. Yet there were an estimated 164.79 million stunted and 137.95 million underweight children in developing countries in 2005. Figures 1 and 2 show that most of the reductions in undernutrition since the 1980s has been achieved in Asia and Latin America. In Africa, the number of stunted children increased, as did both the proportion and number of those underweight.

Figure 1: Estimated prevalence of stunted preschool children 1980-2005

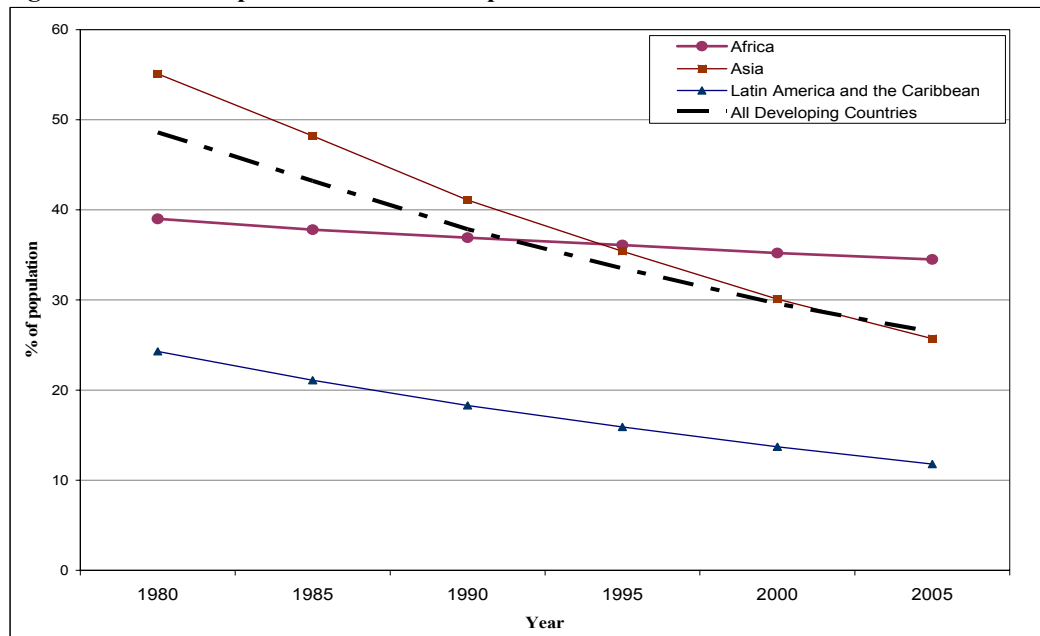
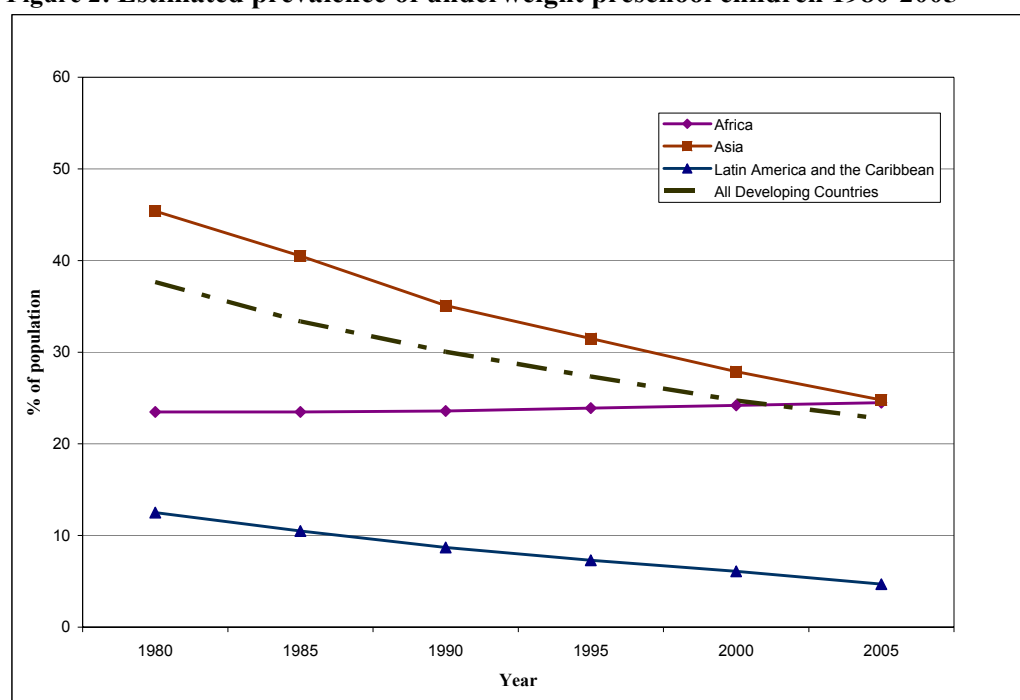


Figure 2: Estimated prevalence of underweight preschool children 1980-2005



Source: UN SCN, 2004

Preschool children defined as children under 5 years of age

MICRONUTRIENT DEFICIENCIES

Vitamin A, iron, zinc and iodine are the most widespread nutritional deficiencies globally and they affect women and young children disproportionately. They may or may not overlap with protein and energy deficits. Vitamin A deficiency is widespread throughout the developing world, affecting between 78 and 254 million people, including an estimated 127 million children (UNSCN 2004; West 2002). Shortage of the nutrient in the diet can limit growth, weaken immunity, cause xerophthalmia (an irreversible eye disorder leading to blindness), and increase mortality. 70 percent of preschool children in Benin and Kenya are sub-clinically vitamin A deficiency, compared to just 5 percent in Venezuela, revealing the wide variability in the condition's prevalence among developing countries (Sommer and West 1996).

Iron deficiency is estimated to be the most prevalent nutritional deficiency, affecting four to five billion people. The estimated prevalence of iron deficiency among children under five years of age in 80 developing countries in 2004 was 54 percent, as compared to an estimated 34 percent who are vitamin A deficient. Again, the range in prevalence between countries is wide. An estimated 20 to 35 percent of children under five years of age are iron deficiency anemic in Latin America and Southeast Asia, compared to an estimated 75 to 85 percent in many African countries (Adamson 2004). In young children iron deficiency may impair growth, cognitive development and immune function. In school-aged children, it can affect school performance, and in adults it may lower work capacity. Iron deficiency anemia is responsible for tens of thousands of maternal deaths each year (UNSCN 2004).

Iodine and zinc deficiency are also widespread and account for a large share of the poor development, health, and survival outcomes of children in developing countries (UNSCN 2004). Deficiencies of key vitamins and minerals continue to be pervasive, and they overlap considerably with problems of general undernutrition (underweight, wasting and stunting).

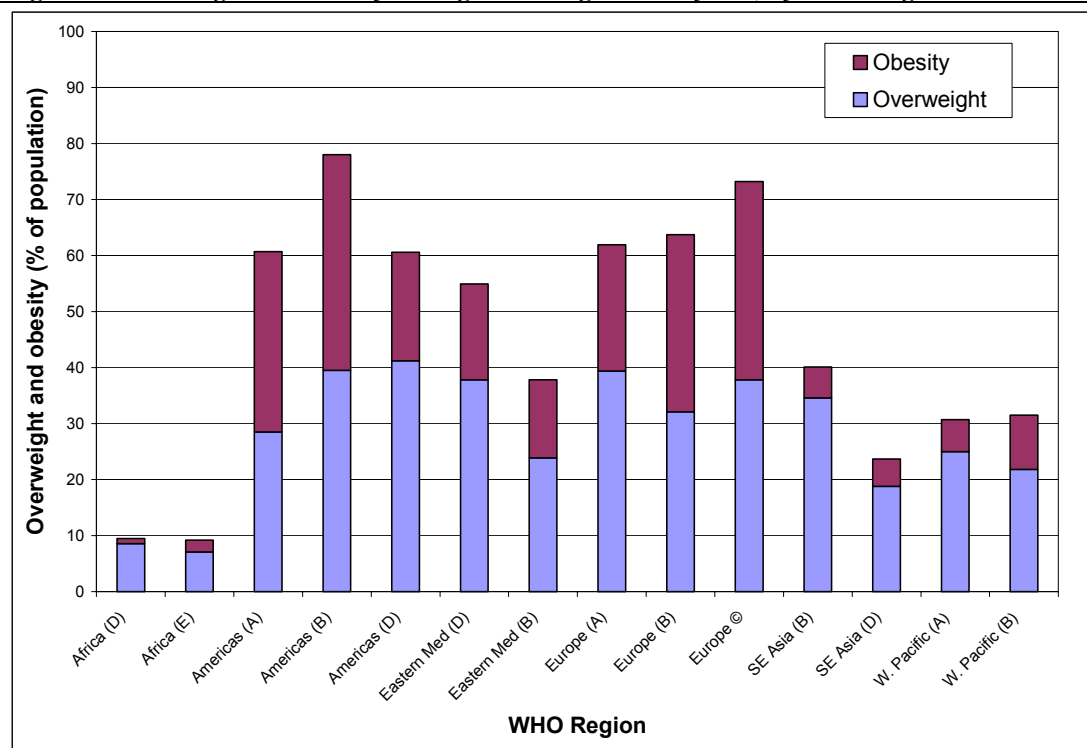
OVERWEIGHT, OBESITY AND DIET-RELATED CHRONIC DISEASES

A set of very different nutrition-related outcomes affect people whose nutrient intakes exceed their energy expenditures, resulting in obesity and a variety of chronic diseases associated with excess weight, including heart disease and diabetes. Among poorer populations in particular, energy-dense, low quality diets are likely to remain deficient in essential micronutrients. Overweight and obesity are now highly prevalent in every region of the world except Africa.¹ The prevalence of overweight children under five is also increasing throughout the developing world, and especially in Africa. The prevalence of childhood obesity in the developing world increased by 17 percent between 1995 and 2005, whereas in Africa it increased by 58 percent (figure 3). The reason why Africa is experiencing such an exaggerated trend is not entirely clear owing to a lack of data, but the rise in prevalence of overweight among mothers is likely to be part of the explanation (World Bank 2006). The prevalence of overweight is considerably higher in urban areas in the developing world, but in Latin America, the Middle East, and South Africa, overweight is also higher than underweight in rural areas (Mendez and Popkin 2004). Overall, the World Health Organization predicts that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese (World Health Organization 2006).

Overweight and obesity are strongly associated with the risk of several chronic diseases, including diabetes, cardiovascular diseases, and several types of cancer. Chronic diseases are the largest cause of death in the world, led by cardiovascular disease (17 million deaths in 2002, mainly from ischemic heart disease and stroke) followed by cancer (7 million deaths), chronic lung diseases (4 million), and diabetes mellitus (almost 1 million) (Yach et al. 2004). Although chronic diseases have been the leading cause of death in developed countries for decades, 80 percent of deaths from chronic diseases now occur in developing countries, where cardiovascular disease is the leading cause of mortality (World Health Organization 2005). The global prevalence of the leading chronic diseases is projected to increase substantially over the next two decades. The number of individuals with diabetes for instance is projected to rise from 171 million or 2.8 percent of the global population in 2000 to 366 million, or 6.5 percent in 2030 - 298 million of whom will live in developing countries (Wild et al. 2004).

¹ Overweight is defined as a body mass index (BMI) (weight/height square) greater than 25; obesity is defined as BMI greater than 30.

Figure 3: Overweight and obesity among women aged 45-59 years, by WHO region



Source: (James et al. 2004). Data collected between 1990-2000

*Africa D comprises northern and western parts of sub-Saharan Africa e.g. Nigeria, Ghana

Africa E comprises central, eastern and southern parts of sub-Saharan Africa e.g. Kenya, Mozambique

America A comprises North America and Cuba

America B comprises the Caribbean and some Latin American countries e.g. Mexico, Venezuela

America D comprises some Latin American countries e.g. Guatemala, Peru

Eastern Med B comprises much of the Middle East and some of North Africa e.g. Tunisia, Saudi Arabia

Eastern Med D comprises a countries in the Middle East, North Africa and Asia e.g. Egypt, Morocco

Europe A comprises most of Western Europe

Europe B comprises some of Eastern Europe and Central Asia

Europe B comprises the rest of Eastern Europe and Central Asia

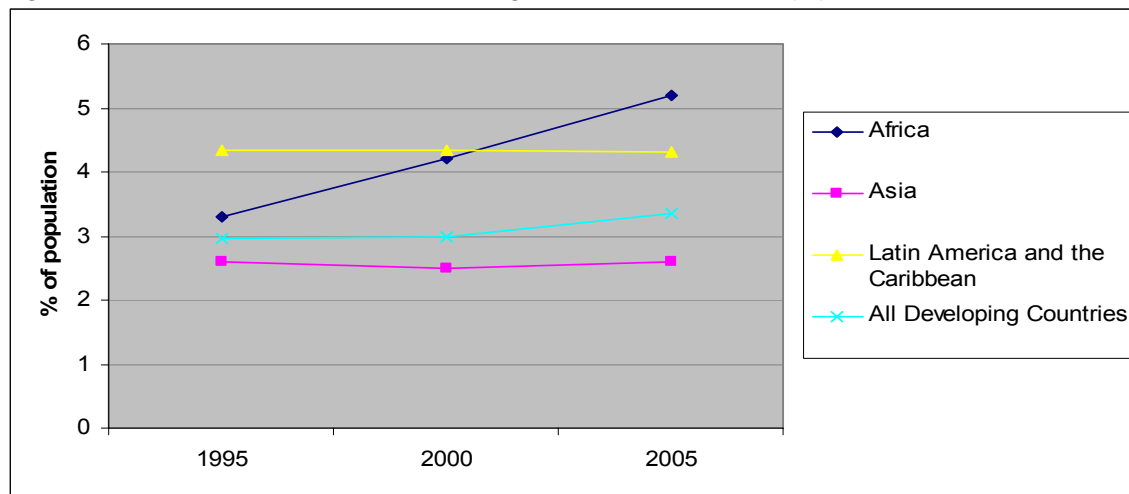
Southeast Asia B comprises Indonesia, Sri Lanka and Thailand

Southeast Asia D comprises most of South Asia e.g. Bangladesh, India

Western Pacific A comprises Australia, New Zealand, Singapore, Japan and Brunei

Western Pacific B comprises the China, some countries of East Asia e.g. Vietnam, and the Pacific Islands

Figure 4: Estimated Prevalence of Overweight Preschool Children (%)



Source: SCN (2004).

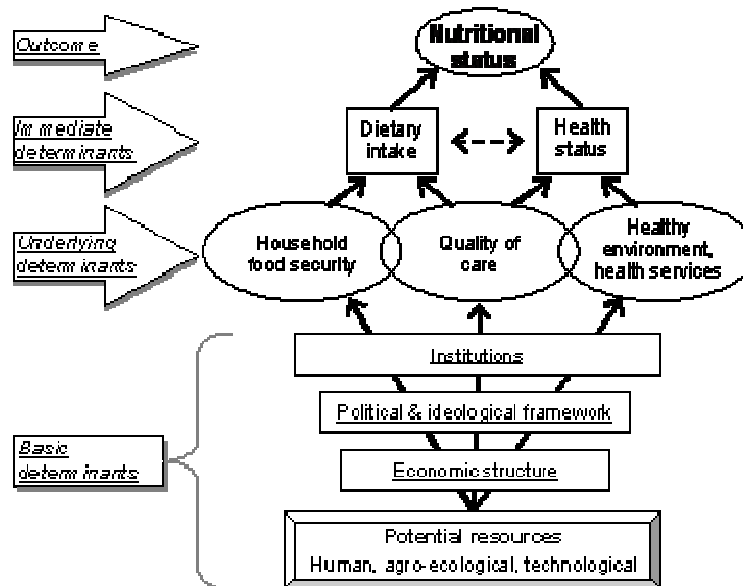
Preschool children defined as children under the age of 5.

Structure of the report. The background and description of types of adverse nutrition outcomes given in this introduction is followed in chapter 2 by a treatment of the determinants of human nutrition, setting out a number of pathways through which agriculture can potentially affect nutrition. Chapter 3 presents a review of available evidence of how agricultural interventions influence nutrition outcomes. Chapter 4 presents a series of four more detailed case studies of agricultural interventions that had explicit nutrition-related objectives. Chapter 5 examines the changes in agriculture and nutrition that are affecting the operational contexts in which nutrition-focused agricultural interventions are carried out. Chapter 6 focuses on the institutional issues related to the operationalizing agricultural development strategies that have nutritional objectives, primarily at the national level. It maps out the state-level institutions involved with agriculture and nutrition, and analyzes the barriers that have posed problems for closer coordination in the past. Chapter 7 draws a set of conclusions as to how agricultural interventions and investments could accelerate improvements in nutrition in low and middle income countries.

2: DETERMINANTS OF HUMAN NUTRITION AND THE PATHWAYS LINKING AGRICULTURE AND NUTRITION

International development agencies have been designing approaches and programs linking agriculture and nutrition to address the problem of malnutrition since the 1960s. The conventional link has been from agriculture to food security. The lack of an explicit indicator of food security led to the use of anthropometric indicators to measure nutritional status. Yet these indicators capture far more than food security as illustrated in a conceptual framework of nutrition developed by UNICEF (UNICEF 1990).

Figure 5: Conceptual Framework of the Determinants of Nutritional Status



Adapted from UNICEF 1990

Food security is just one underlying determinant of nutrition, along with the quality of maternal and child care, the adequacy of local health services, and whether individuals are living in a healthy environment. The more immediate determinants of nutritional status are dietary intake and health status. The focus of this report is on the connection between agricultural production and dietary intake via food security.

In the 1970s food price spikes prompted alarm and concerns about food availability and brought the term “food security” into the development arena. Programs operated under an assumption that agriculture’s primary role in this equation was to address protein-energy deficiencies by increasing food production and lowering food prices. During the Green Revolution the availability of staple cereals increased globally and prices fell proportionately, yet protein-energy malnutrition persisted. Publications on agriculture-nutrition linkages became critical of what appeared an implicit assumption that improved nutrition would follow naturally from the gains achieved through production increases. (Box 1 lists the key publications to emerge from this period.) In 1981 the World Bank commissioned a report by Per Pinstrup-Andersen titled *Nutritional Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches*, which

argued that if agricultural development was to better contribute to improving nutrition, nutritional aims would have to be explicitly incorporated into agricultural production decisions. Amartya Sen's work on famines and the concept of entitlements, together with the failure to achieve real improvements in nutritional outcomes, led food security practitioners to shift their attention to income and to the economic access to food.

In the 1980s, the focus shifted to how agriculture could help improve nutrition by increasing income among agricultural communities. The change was reflected by publications produced in the early 1990s. In particular, the nutritional implications of agricultural commercialization, the shift to cash-cropping, were examined. Studies found that even when commercial agricultural schemes increased income, they did not substantially improve child nutritional status, leading to the conclusion that income alone could not solve malnutrition. In the nutrition community, meanwhile, there was a distinct shift in the late 1990s away from concept of agriculture as an intervention to reduce energy deficiency and promote income, and towards the importance of addressing micronutrient deficiencies through agriculture. A conference held in the Philippines in 1999, *Improving Human Nutrition through Agriculture: The Role of International Agricultural Research*, brought together nutritionists and agricultural scientists to assess the role that agricultural research can play in alleviating micronutrient malnutrition, including through emerging technologies such as biofortification (Bouis 2000b). This reflected a shift in emphasis in nutrition programs in general. "Food-based" strategies were developed to promote micronutrient intake, such as through homestead gardening. At the same time the food security definition evolved from a focus on availability and economic access to include food utilization, encompassing diet quality and care issues. This culminated in the 1996 World Food Summit definition of food security:

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."

World Food Summit Plan of Action

Yet even today the conception of "food security" employed by the agricultural community often neglects the nutritional aspects of this more complete definition, and in so doing misses important opportunities to contribute to improved nutritional outcomes. This persistent neglect was a driver in undertaking the work leading to this report. The 1990s also marked a shift to greater focus on women, including intra-household resource allocation issues in agriculture and income control, and care giving. In the early 2000s publications focused on the role of women and on the importance of combining agriculture interventions with nutrition education and behavior change in order to maximize their impact on nutrition. These complementary interventions and their focus on empowering women aimed at integrating actions to address not only the need to increase food availability and access, but also ensuring appropriate child feeding, childcare and health-seeking practices to achieve nutritional impacts.

Box 1: Key Messages from Publications on Agriculture and Nutrition, 1970s-2000s

(Scrimshaw and Behar 1976) - protein-energy malnutrition persists despite the major improvements in agricultural technology that have increased food production.

(Pinstrup-Andersen 1981) - since malnutrition is caused by a variety of factors, simply expanding food production *per se* is insufficient to solve global nutritional problems; increased food production and income are currently the explicit goals of agricultural development projects, while nutrition is only an implicit goal. If agricultural development plans and strategies are to contribute to solving nutrition problems, they should include an explicit goal of reducing protein-energy malnutrition.

(Food and Agriculture Organization 1982) - if development efforts are to reduce malnutrition effectively, nutritional considerations must be incorporated into projects of agricultural and rural development.

(Pinstrup-Andersen et al. 1984) - past agricultural research has facilitated rapid increase in food production in developing countries but this has not been sufficient to address nutrition needs by itself; nutrition should therefore be considered explicitly in decisions about the design of agricultural research in four key ways: focusing on specific crops, considering the effects of the intervention on the overall diet; specifying the desired agricultural technology; and adapting farming systems to meet nutritional goals in low-income farm households

(Pacey and Payne 1985) - targeting of nutritionally vulnerable groups is needed in order to design agricultural interventions to support nutrition, such as through high-energy, low-cost foods and drought and pest resistant crop varieties.

(Kennedy and Bouis 1993) - agriculture affects nutrition through three main pathways: income, sanitation and health environment, and time allocation.

(DeWalt 1993) - impacts of agricultural commercialization on food consumption and child nutrition are mixed and highly determined by control of production/income, allocation of household labor, maintenance of subsistence production, land tenure, and pricing policies for food/non-food crops.

(von Braun and Kennedy 1994) - negative effects of agricultural commercialization on nutrition are not typical, but even when cash cropping increases income, it does not decrease child undernutrition; thus increased income cannot solve malnutrition by itself.

(Bouis 2000a) - breeding nutritionally improved crops can play an important role in alleviating malnutrition.

(Ruel 2001) - although evidence is still weak, some food-based agriculture strategies have been successful in reducing iron and vitamin A deficiency, especially when they were combined with effective behavioral change and communication interventions and had an explicit focus on women's empowerment.

(Pretty and Hine 2001) - the environmental and health problems associated with agriculture affect health and nutrition; sustainable agriculture projects can have positive effects on health and nutrition such as through decreased pesticide use and greater social capital among women.

(Allen 2003) - increasing the production of animal source foods is a potentially sustainable solution to micronutrient malnutrition; the possible adverse effects of excessive increases in animal source food consumption on fat and energy intakes must also be addressed.

(Johnson-Welch 2002) - taking a gender-sensitive approach to agricultural interventions can strengthen the positive impact of agriculture on nutrition.

(Kataki P.K. and Babu 2002) - nutrition should be considered when developing agricultural technologies

(Berti et al. 2004) - investing in the target population broadly, rather than narrowly through agriculture, improves the effectiveness of agricultural interventions; investing broadly in five types of capital (natural, physical, social, human, and financial) increases prospects for nutrition improvement.

Pathways Linking Agriculture to Nutrition

The links connecting agricultural production with food consumption and human nutrition can be direct or indirect. We may characterize these production-to-consumption pathways along a continuum between the most direct and the least direct – the most direct being characteristic of subsistence production, the least direct reflecting the macro-economic effects of agricultural growth on national—and indeed global—populations. Particularly in the case of households that produce principally for their own consumption, nutrition outcomes are the straightforward results of the specific foods the households themselves produce. This relationship quickly loses its directness as production becomes more market-oriented, but the question of what foods are produced—staples, fruits and vegetables, or animal source foods—retains its significance throughout all five pathways.

It is worth noting that agriculture can also affect nutrition through improved health. Nutrition is intuitively a pre-condition for good health, but the relationship runs both ways. Health is also a pre-condition for nutrition, enabling the individual to metabolize the nutrients he or she digests. Thus, if agricultural interventions can support positive health outcomes – by providing conditions conducive to the reduction of infectious diseases for example – nutrition outcomes can be improved. Take, for example, agricultural interventions to improve food safety and reduce the incidence of food-borne diseases, which could help improve nutrition by reducing diarrheal diseases. These broader links between agriculture and health are beyond the scope of this report but were discussed in a recent study by the International Food Policy Research Institute (Hawkes and Ruel 2006).

The pathways linking food production with food consumption and human nutrition along the food supply chain can be usefully captured in terms of five *pathways*:

- Increased consumption from increased food production
- Increased income from the sale of agricultural commodities
- Increased empowerment of women as agents instrumental to improved household food security and health and nutrition outcomes
- Reductions in real food prices associated with increased food supply
- Agricultural growth, leading to increased national income and macroeconomic growth, and to poverty reduction and improved nutrition outcomes.

The pathways are archetypal; representing model forms which in reality are by no means self-contained or mutually exclusive. Subsistence production for instance generally takes place alongside production for sale since few households are self-sufficient in food, and since food is not the only requirement that must be met. Income is therefore very important even among households that produce principally for their own consumption. The income and price pathways are likewise overlapping in that the price reductions resulting from increased food supply are given in real terms and as such serve to raise real income.

Increased consumption from increased food production. Where the degree of market-orientation is low, food consumption is determined quite directly by the level and pattern of agricultural production. The resource endowments of the households (such as land and labor) along with the available technology determine the level of production of different crops, which in turn, determines the consumption patterns of the households. This kind of link is particularly relevant in case of subsistence or semi-subsistence households.

Increases in production can lead to greater food availability and consumption at the household level. This, in turn, can increase the food intake of vulnerable household members assuming that intra-household processes are favorable. The type of food produced influences whether this will affect mostly diet quantity (energy intakes) or diet quality (micronutrient intakes). Staple foods can contribute significantly to alleviating energy (calorie) gaps, whereas fruit and vegetables, dairy, eggs, fish and meat products can help alleviate gaps in essential micronutrients such as iron, zinc and vitamin A in addition to energy gaps. Animal source foods and fruits and vegetables make staple foods more palatable, thus leading to overall greater food intake. Animal source foods themselves are also rich sources of energy and protein. Some proportion of the food produced may very well be intended for sale on local markets. Some households may for instance meet their staples requirements themselves while depending on markets for other products like fruits and vegetables. Others may rely mainly on home gardens for fruits and vegetables. Whatever role production-for-income plays in this scenario is secondary to the principal purpose of producing food – the household's own food requirements.

Increased income from the sale of agricultural commodities. As the market orientation of agricultural households increases, the consumption of own-production pathway declines in significance as increases in agricultural productivity or production can lead to higher incomes among producers. Income from the sale of surplus production, which plays a secondary, supplemental role in the subsistence-oriented household, now assumes a primary role, while production for the household's own consumption becomes supplemental. The principal criterion determining the selection of which foods to produce becomes their tradability rather than their role in the household's own diet(s). The intensification of staple food production, and expanding opportunities for livestock, fish, and fruit and vegetable production, can also generate employment for landless or land-poor individuals. Increases in income can in turn translate into improvements in household food security and individual food intakes.

The additional income may have little or no effect on energy intakes, but rather lead to a shift in the types of foods which are purchased. Staple food producers for instance may use the income earned from the sale of their produce to buy fruits, vegetables, meat, and fish, and their households may consume these as substitutes for some proportion of the staples they consume. This substitution can significantly improve the micronutrient status of household members without necessarily increasing energy intakes. The extent of the nutritional benefits relies naturally on the nutrient content of the higher-value substitute food; but it also relies on how well the substitutes offset existing nutritional deficits within the household. The distribution of different types of food among different individuals within the household, and among the more nutritionally vulnerable individuals in particular, is a vital determinant of nutrition outcomes. The distribution of nutrition and other health-related benefits within the household is of course a function of decision making, and especially in resource-poor households, relies on who makes these decisions. The individuals with the greatest influence over these decisions tend to be the individuals who control household resources. In the production-for-own-consumption scenario, these resources center around control over the households basic resource endowment of land, labor, and capital. In the production-for-income scenario, the most important resource tends to be income, and the most important decision makers are those who control income flows.

This becomes an urgent consideration for nutrition outcomes when one considers that additional income might not be spent on food or well-being.

The empowerment of women agriculturists. The importance of women in household decision making is such that they comprise a separate pathway through which agricultural production and its income effects can bear upon nutrition. Studies from Africa, Asia and Latin America clearly show that women's income has a significantly greater positive effect on child nutrition and household food security than men's income (Quisumbing et al. 1995, Katz 1994; Hoddinott and Haddad 1994). Women are also more likely than men to invest in their children's health and nutrition. Agricultural interventions that result in increased income and control of resources by women producers can therefore dramatically increase the potential for positive nutrition outcomes. The positive effects of increases in women's income on childhood nutrition moreover appear most pronounced among the lowest income groups.

In their roles as producers and earners as well as in their roles as care givers, women who are reached by communication and education services that relay information on health and nutrition issues appear to be particularly effective agents in delivering improved nutrition outcomes. In addition, agricultural programs that reduce time resource constraints on women, particularly in rural areas, enable them to fulfill their multiple roles more effectively. These roles include child- and elder-care, food production, and food preparation, all of which have marked significance for nutrition outcomes. The incorporation of this gender dimension in agriculture programs is often missing in developing countries. Women are without question prime agents of household food security, but they are generally also time- and resource-constrained agents, and especially in rural contexts. The variety of roles they play, from child- and elder-care to food production to food preparation to water collection to a variety of income-generating activities reveal a picture of the challenges they face. Agricultural interventions that take the above factors into consideration are more likely to have positive nutritional outcomes.

Reductions in real food prices associated with increased food supply. Increased food supply reduces food prices and effectively raises the real income of people who enjoy access to markets. This produces the same consumption outcomes as the income effect described in the second pathway. The food price pathway is however differentiated by its effect on non-agricultural households and net consumers, as opposed to the income pathway which pertained to net food producers.

This food retail price link is driven in large measure by improvements in the technologies that are employed by producers, as well as by changes in marketing which together lower the cost of production and hence consumer prices. This transfers some of the benefits of the technological change from producers to consumers. Even if prices are lower, the impact on the net incomes of the agricultural households will depend on new costs of production and the elasticity of demand. The most common example of this link is the effect of Green Revolution technologies on the price of grains. Similarly, in many countries, rapid technological developments coupled with trade reform and foreign investment policy reforms in food processing gave access to a wider set of technologies. For example, mechanical devices have been replaced by electronic and very recently by computerized machines. Micro electronics-based technologies permit increased automation of a wide range of operations in industries (Mody et al. 1992). Simultaneously, there have been numerous organizational changes in materials management, quality management,

inventories and distribution. These technological developments are reducing the trade-off between quality and price at larger scales of operation by enabling industrial units to supply high quality at cheaper prices (Wellenius 1993).

Agricultural growth can theoretically lead to broad improvements in nutrition simply by virtue of its contributions to macroeconomic growth and national income. Increases in agricultural productivity have been and remain important drivers of sustained economic growth, particularly among countries in relatively early phases of economic development. In general, the use of improved technologies leads to an initial period of growth in staple food production within a small-scale, labor-intensive agriculture sector. The growth in production in turn results in lower food prices, higher real wages, and a related reduction in poverty rates. Reduced food prices enable greater access to food, resulting in better nutrition for the general work force while also freeing up additional household resources from food and other expenditures, to savings and productive investments. Recent evidence suggests that growth in agricultural productivity can also help to reduce poverty. A cross-country analysis published in 2006 found that at the national level a one percent increase in agricultural yields effectively decreases the percentage of population living on less than a dollar a day by 0.64 to 0.91 percent, with a slightly higher reduction for African countries (World Bank 2006). Overall, however, the economic growth to malnutrition relationship is modest. A doubling of gross national product (GNP) per capita in developing countries has been associated with a much more modest reduction in childhood undernutrition - in the order of only 23 to 32 percent (Haddad et al. 2003).

3: THE IMPACT OF AGRICULTURE INTERVENTIONS ON NUTRITION OUTCOMES

The potential of agricultural production to contribute to improved nutrition outcomes through the set of pathways presented in the preceding chapter is theoretically sound, but finding evidence that empirically establishes the degree of this contribution proves problematical. The literature documenting the indirect pathways of food retail price and agricultural growth generally fails to report nutrition impacts at the household or individual level. The impacts it measures tends to focus on more aggregate indicators of food availability. Given the range of variables which come together to determine nutrition outcomes—many of them non-agricultural—collective indicators are generally less useful than household and individual indicators in measuring the impacts of agricultural production. These lower level outcomes can be observed more clearly among the immediate beneficiaries of agricultural programs or interventions, making the more direct food-for-own consumption, income, and women’s empowerment pathways the focus of the review presented here.

The review is based on a systematic search of recently published literature and a limited search of unpublished documents, as well as personal contacts with project officers and international agency staff. The search centered on studies of agriculture interventions which had evaluated individual-level nutrition outcomes, such as child nutritional status, individual food or nutrient intakes, and diet quality.² It drew on previous reviews (Peduzzi 1990; Soleri et al. 1991a, 1991b; Gillespie and Mason 1994; Ruel 2001; and Berti et al. 2004) with the purpose of updating and expanding on them. Much of the analysis related to animal source foods was taken from Leroy et al. (in preparation). A description of search methods and results is provided in the appendix.

“Interventions” are defined broadly to mean changes purposefully introduced into an existing agricultural system in order to promote new technologies, management practices, production and marketing methods, and other aims which may or may not include components designed to improve nutrition. Those which do entail explicit nutritional objectives are emphasized in this report because these interventions are more likely to document nutrition outcomes. The nutrition outcomes themselves are treated in terms of:

- *household level food consumption*, which includes household-level consumption of foods and food groups, or energy (calories); and household expenditure on foods and food groups
- *individual food and nutrient intake*, which includes intakes of macro- and micronutrients, and of foods rich in specific micronutrients that are the focus of interventions like those addressing vitamin A and iron deficiencies
- *nutritional status*, which includes anthropometric indicators such as height, weight, body mass index, and micronutrient-specific indicators such as serum retinol (indicator of vitamin A status), hemoglobin (indicator of iron status).

² Other types of agricultural interventions such as non-food crops or oil seed crops, or technology-based rather than crop-based interventions were excluded from the review because they typically fail to examine nutrition impact.

THE NUTRITIONAL IMPACTS OF AGRICULTURAL INTERVENTIONS

Interventions involving staple foods. The only agricultural interventions involving staple foods that have been evaluated from a nutritional perspective concern agricultural commercialization – the conversion from staple subsistence food production to commercial food production. This type of intervention aims to improve nutritional outcomes through both the own-consumption and the income pathways, with indirect impacts through the agricultural growth and price pathways.

Some early conceptual reviews of links between agricultural commercialization and nutrition had suggested the potential for negative impacts, though some of these examples related to conversion to non-food crops (Fleuret and Fleuret 1980). One early review showed mixed impacts on nutrition, some negative and some positive but also identified methodological issues that constrained interpretation and comparison (von Braun and Kennedy 1986). Given these uncertainties, the authors designed and undertook a series of micro-level case studies that included assessment of nutrition outcomes as an explicit objective (von Braun and Kennedy 1994). The study's focus was on the impact of commercialization on energy intakes rather than on diet quality or micronutrient intake, and was therefore consistent with the then-prevailing idea that energy intakes were the primary constraint in the diets of the poor (McClaren 1974; Waterlow and Payne 1975). Still, shifts towards more diversified diets were documented where these occurred. These studies also reported results disaggregated by income group, and examined the role of control of income by women as opposed to men.

While assessing nutrition impacts were among the objectives of these case studies, the interventions being analyzed had not been designed to impact child nutritional status per se. Their objectives were more general and aimed at increasing food production and/or raising incomes among farm households, and therefore did not include communication or behavior change strategies related to child feeding and nutrition.

Results from these and closely related studies were synthesized, yielding a series of conclusions that are summarized in table 2 (DeWalt 1993; Kennedy et al. 1992; von Braun and Kennedy 1994). The principal results did not differ substantially between case studies of the commercialization of staple food crops versus other cash crops. In sum, the case studies documented fairly consistent positive impacts on focus crop production, household income, and food expenditures, but no substantial impacts on young child nutritional status (the main indicator assessed across studies). In one case where subsistence food production was not maintained, outcomes were worse. DeWalt (1993) concluded that a focus on commercialization per se was misplaced, and that impacts on food consumption and child nutrition were determined by control of production and income, allocation of household labor, maintenance of subsistence production, land tenure, and pricing policies for both food and non-food crops. Kennedy et al. (1992) also attributed the lack of impact on child nutritional status to the generally high levels of morbidity observed in project areas.

Overall, the authors made the following nutrition-related conclusions:

- Participation in cash-crop schemes generally resulted in increased household income.
- Increases in income were accompanied by increases in food expenditures, but impacts on consumption were also dependent on changes in relative prices.

- Dietary energy intakes increased in most cases but decreased in some, as food expenditures shifted to more expensive items such as meat and fruits; potential improvements in diet quality were suggested but not quantitatively assessed.
- Increases in women's income were documented in some studies, and were generally linked to increases in household energy consumption; this effect was most pronounced among the lowest income groups.
- Overall, participation in cash-cropping schemes did not have a significant impact – negative or positive – on young child nutritional status.
- Children's morbidity levels were generally high and not impacted by the schemes, and were interpreted to be a major constraint to improving child nutritional status.

Evidence from this set of studies suggests that cash-cropping was associated with greater household income, including greater income controlled by women in some cases, as well as greater food expenditures. This, however, did not consistently translate into greater energy intakes, as households shifted to more expensive sources of energy. This change in food consumption patterns may have resulted in greater dietary diversity, which is generally a sign of improved overall diet quality, but the studies did not specifically assess this aspect. The studies therefore suggest that, although agricultural interventions that promote commercialization may effectively increase income and food security, they are not sufficient to improve childhood nutrition if they are not complemented by interventions that specifically address other determinants of child nutrition such as improved health and care-giving practices.

Table 2: Key results from selected studies of agricultural commercialization

Country Crop References	Intervention or technological change	Study design <i>Concern with methods</i>	Differences in income ^a	Differences in household energy consumption ^a	Differences in individual energy intakes and nutritional status	Other key results
West Kenya Irrigated rice (Niemeijer and Hoorweg 1994) ^b (Niemeijer et al. 1988) ^d	2 rice irrigation schemes. Irrigated land was expropriated and redistributed to smallholders for rice production only. Initially, all tenants lived on scheme but eventually some moved off scheme. No livestock and only small rainfed plots on scheme.	Cross-sectional survey comparing: Resident tenants Non-resident tenants Individual rice growers Non-rice growers <i>No randomization and no control for selection bias</i>	Total incomes were similar across all four groups but sources of income were least diverse for resident tenants and most diverse for individual rice growers	Household energy consumption increased with increasing diversity of income sources	Child energy intakes were lowest and nutritional status was substantially worse among resident tenants. Other groups fared better and were similar.	In-depth follow-up study among resident tenant households revealed higher per capita food expenditures from income controlled by women
Rwanda Potatoes (Blanken et al. 1994) ^b (von Braun et al. 1991) ^c	Expansion of potato production in former forest reserve, allowing access to additional land for food production. During reforestation, potato production was allowed to keep weeds down. However, potato cultivation expanded rapidly and uncontrollably.	Cross sectional survey comparing : Farms with and without access to “extra” forest reserve land under potato (monocropped) <i>No randomization and no control for selection bias</i>	Potatoes grown on “extra” land were the only crop marketed to a significant degree but the amount sold varied from 8% to 45% based on wealth quartile; potato production expanded rural wage labor market	A 10% increase in income was associated with a 5% increase in energy consumption A lower degree of commercialization raised energy intakes over and above price and income effects	Increases in household energy consumption were associated with better child nutritional status but this effect was very small Child nutritional status was more strongly related to health and sanitation	Female-headed households consumed more energy (per unit); this effect was strongest in poorest households and did not hold in wealthiest
Zambia Hybrid maize (Kumar and Siandwazi 1994) ^b	Introduction of hybrid maize. A number of different varieties were introduced over a period of years. This study	Repeated household surveys comparing : Households in high and low adopting areas, and comparing adopters/non-adopters <i>No randomization; authors addressed selection bias by</i>	Incomes were 33- 45% higher in high adoption areas whether household adopted or not; incomes of adopters were 25% higher than non-adopters	Per capita consumption of energy and other nutrients followed same pattern as income (higher intakes among adopters and in high adoption areas)	Results for child nutritional status were mixed: Higher weight but lower height in high adoption areas (young children) and lower weight among older children. In	

Country Crop References	Intervention or technological change	Study design <i>Concern with methods</i>	Differences in income ^a	Differences in household energy consumption ^a	Differences in individual energy intakes and nutritional status	Other key results
		<i>comparing high and low adoption areas, as well as adopters/non-adopters</i>			adopting households, young child height was slightly higher but weight and height were lower among older children	
The Gambia Irrigated rice (von Braun et al. 1994) ^b (von Braun 1988) ^d	Large scale rice irrigation scheme. Explicit attempt to maintain traditional use rights of women farmers through giving women priority during registration of plots. Production technology in the scheme is heterogeneous with varying levels of water control.	Repeated household surveys in area of new state-owned large-scale rice irrigation scheme, with 4 production systems: Traditional swamp rice Small pump irrigation Partial water control (rain or tide) Central irrigation drainage <i>No randomization; authors explored determinants of adoption.</i>	New technology resulted in substantially increased yields and allowed a second crop, but did not have large impact on marketed surplus Substitution effects in labor allocation meant that increased rice production was accompanied by decreases in other cereals and groundnuts (- \$0.64 per \$1.00 rice)	Consumption (energy) increased with expenditure quartile in both wet (hungry) and dry seasons. A 10% increase in expenditure was associated with a 5% increase in energy (wet season) Consumption was not correlated with household cereal production, but was correlated with women's share of cereal production	Women's seasonal weight fluctuations were buffered in households with greater access to new rice land Child height was lowest in the lowest expenditure quartile but similar across Q2 – Q4 Child weight increased with household energy intakes; access to new rice land did not have other independent effects, positive or negative	Traditional swamp rice was a “women's crop”; scheme sought to assure women's access to new project rice land; however, holding title to land did not ensure control of new resources. Women's control of production and income was decreased for new higher input and higher yielding rice, resulting in a de facto shift of resources and control

Mexico Sorghum (DeWalt et al. 1990) ^d	Adoption of sorghum production in areas formerly dominated by subsistence agriculture (maize and beans); sorghum production increased to meet increasing demand for livestock feed.	Ethnographic methods (participant observation and informal interviews) followed by a household survey in four communities where sorghum was produced as a cash crop. Communities represented range of ecological conditions, landholding size, irrigation, and access to credit, technical assistance and markets. <i>No randomization.</i>	Incomes were highly diversified. Access to good quality and irrigated land determined income, rather than participation in cash cropping.	(neither food consumption nor dietary intake were measured)	There was no relationship between sorghum production and child nutritional status. Income was associated with child nutritional status, but only weakly.	
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^a Income and household consumption expressed per adult equivalent unit; ^b Included in von Braun and Kennedy (1994); ^c in Kennedy et al (1992); ^d in DeWalt (1993)

Interventions involving fruits and vegetables. Despite the wide variety of fruit and vegetable production systems that exist, the literature review revealed that homestead garden production systems have been the only ones implemented with an explicit nutrition objective. These primarily target the first pathway, increasing own production for consumption, with a secondary pathway of income increases from sales of higher value products.

Homestead gardens take a wide variety of forms, in backyards, farmyards, kitchens, containers, small patches of available land, vacant lots, on rooftops and table tops, and along roadsides and the edges of fields. They are generally close to a house and source of water, and are managed by family members using low-cost inputs. Their products include fruits, vegetables, herbs, condiments, and sometimes secondary staples like legumes and sweet potatoes, most of which are grown for household consumption. The nutrition impacts of homestead gardens have been relatively well documented. This section draws on previous reviews, starting with the VITAL reviews, and then reviews by Gillespie and Mason (1994), Ruel (1991) and Berti et al. (2004).

In 1990 and 1991 the USAID-funded Vitamin A Field Support Project (VITAL) carried out an assessment of past and then-current household garden interventions and their impacts on nutrition outcomes in order to inform the planning of future research and initiatives. The assessment focused on the effects of homestead gardens on the intake of vitamin A-rich foods and improving vitamin A status. The review yielded a number of recommendations on design, targeting and evaluation of homestead gardens and on how to strengthen their nutritional impact, notably through the female empowerment pathway. Interventions should focus on women, and provide nutrition education services to promote appropriate processing, storage, and cooking techniques of vitamin A-rich foods. They should also promote a diverse variety of vitamin A-rich foods to meet both subsistence and marketing needs, and take into account cultural preferences when selecting which foods to introduce.

A review by Gillespie and Mason published in 1994 considered 13 programs aimed at improving diet quality, seven of which included homestead gardening. Four of these were combined with social marketing activities, and all four exhibited a number of indirect benefits like increasing women's income and social status. Yet only one project, carried out in Bangladesh, showed a positive effect on vitamin A status in addition to increased energy intakes and improvements in the economic status of women. The results of more recent reviews are summarized in table 3.

Table 3: Summary of the evaluation findings of horticultural and nutrition projects

Country (Reference)	Type of intervention	Design	Nutrition Impact assessed	Other Impact assessed
Bangladesh ^{R,B} (Greiner and Mitra, 1995)	Homestead gardening with provision of seeds. Farming education Nutrition education	Pre-post, with control	Slight decrease in night blindness indicating improved vitamin A status	Increase in % HH growing vegetables and fruit in both treatment and control Increased knowledge of function of Vitamin A
*Bangladesh ^{R,B} (HKI/AVRDC, 1993)	Homestead gardening with vegetables, training on agriculture, provision of seeds, nutrition education.	Pre-post, with control	Improvements in stunting and in underweight	Increase in vegetable production, size of plot cultivated, year-round availability of vegetables, income, women's control over income, vegetable consumption per capita, children's vegetable intake. Intervention children had less respiratory infections
Bangladesh ^R (IFPRI et al., 1998)	Vegetable production, fishponds, and credit and agricultural training	Pre-post, with 3 groups: fishponds, vegetables, control	No change in hemoglobin in any group, implying no change in iron status	Increased production of fish and vegetables. No increase in consumption of fish in fishpond group. Increase of vegetable intake in vegetable group.
Ethiopia ^{R,B} (Ayalew et al., 1999) (Ayalew et al., 1999)	Training on agriculture, food preparation sessions, provision of seeds. Health and nutrition education.	Pre-post, with control	Lower prevalence of clinical signs of Vitamin A deficiency in treatment area	More gardens and better Knowledge, Attitudes, Practices (KAP) about Vitamin A and clinical eye signs of deficiency in treatment area. More diversified diet, higher Vitamin A food frequency scores.
Guatemala ^B (Phillips et al., 1996)	Provision of seeds, extension services and nutrition education for the promotion of VA-rich foods	Pre-post, with control	Data not collected on nutrition indicators (only dietary indicators)	Control children without garden with Vitamin A-rich vegetables have more Vitamin A deficiency
India ^R (Chakravarty, 2000)	Homestead gardening and nutrition and health education.	Pre-post	Decrease in ocular signs/symptoms of Vitamin A Deficiency	Increase in %HH growing vegetables. 40% HH sold 10-25% of produce. Increased Knowledge Attitude Practice on vitamin A and weekly intake of vitamin A-rich garden produce more than doubled
Indonesia ^R (de Pee et al., 1998)	Social marketing with mass-media, and 1-on-1 communication to increase intake of targeted Vitamin A-rich foods	Pre-post	Increased serum retinol with increased egg consumption, dose-response relationship indicating improved vitamin A status	Increased % children and mothers consuming at least 1 egg in previous week, in amount of Vegetables prepared/person/day, in Vitamin A intake from eggs and plants
Kenya ^{R,B} (Hagenimana et al., 1999)	Introduction of a new variety of sweet potatoes and training in food-processing techniques. Nutrition education .	Pre-post, with control	Data not collected on nutrition indicators (only dietary indicators)	Higher Vitamin A food frequency scores for children in intervention versus control group

Nepal ^{R,B} (CARE/Nepal, 1995)	Homestead gardening, irrigation, agriculture extension, seeds	Pre-post	Deterioration of nutritional status of children during study (no control)	Increase in % HH producing vegetables. Insufficient Vitamin A intake for mothers and children pre and post.
Niger ^R (Parlato and Gottert, 1996)	Promotion of home production. Multi-media education campaign promoting consumption of Vitamin A-rich foods	Pre-post	Data not collected on nutrition indicators (only dietary indicators)	Increase in vitamin A knowledge of women, intake of vitamin A-rich vegetables (children), purchase and consumption of liver (a food targeted by the intervention to increase vitamin A) by women and children.
Peru ^R (Carrasco Sanz et al., 1998)	Nutrition education in community kitchen with capacity building	Pre-post members/non-members	Reduction in prevalence of anemia	Increased quality of diet and intake of iron-rich foods as well as vitamin A, heme iron and proportion of absorbable iron.
Philippines ^B (Brun et al., 1991) (Solon et al., 1979) (Popkin et al., 1980)	Promotion of production of Vitamin A-rich fruits and vegetables with provision of seeds and seedlings and advice on agricultural practices	Paired pre-post	Improved weight-for-height and decrease in severe wasting. No change in serum retinol or clinical eye signs of severe Vitamin A deficiency, implied no change in Vitamin A status	Increase in children's Vitamin A intake
Philippines ^B (Solon et al, 1996)	Promotion of homestead gardens with some target vegetables. Provision of seeds and cuttings. Mass media campaigns, social marketing and nutrition education.	Pre-post, with control	Data not collected on nutrition indicators (only dietary indicators)	Increased production of 5 types of vegetables with increased vegetable consumption and Vitamin A intake in intervention group. Decrease Vitamin A intake in control group by 48%.
Senegal ^B (Brun et al., 1989)	Promotion of homestead gardens and sale of produce. Nutrition education and agriculture education	Survey of those with & without homestead gardens (baseline; 10-12 years later)	Data not collected on nutrition indicators (only dietary indicators)	Consumption increased for some nutrients, decreased for others.
*Tanzania ^{R,B} (Kidala et al., 2000)	Agriculture, promotion of home production, consumption and storage of Vitamin A-rich foods. Health and nutrition education.	Treatment/control Post	Lower serum vitamin A and higher helminths in treatment area. Overall, higher intake of Vitamin A-rich foods associated with higher serum Vitamin A	Higher % HH with homestead gardens and producing Vitamin A-rich vegetables in treatment area. Better Knowledge, Attitudes, Practice about Vitamin A, higher % using solar driers for Vitamin A foods, higher 7-day frequency of intake of Vitamin A foods.
Tanzania ^R (Mulokozi et al., 2000)	Promotion of solar driers. Nutrition and health education.	Pre-post, with control	Data not collected on nutrition indicators (only dietary indicators)	8% women adopted solar driers in intervention area. No significant increase in % selling or income from selling dried vegetables. Vitamin A food frequency score higher

				in treatment group and among adopters with increased intake of animal products.
Thailand ^{R,B} (Smitasiri and Dhanamitta, 1999) (Smitasiri et al., 1999) (Attig et al., 1993)	Seed distribution, training of women farmers, promotion of gardens, fishponds, and raising chicken. Nutrition education and social marketing.	Pre-post, with control	Increased serum retinol, decreased Vitamin A deficiency (in school girls). Increased mean hemoglobin, decreased anemia and low serum ferritin (not significant) implies improved iron status	Increased Knowledge Attitudes, Practice on Vitamin A and iron, increased Vitamin A intake, no change in fat intake, increase in iron intake in some targeted groups increase in vitamin C intake in lactating women. No change in controls.
*Vietnam ^R (English et al., 1997) (English and Badcock, 1998)	Homestead gardens, fishponds, animal husbandry. Nutrition education	Treatment/ control Post	Data collected only on dietary indicators	Treatment group: lower severity and incidence of respiratory infections, better growth, greater fruit and vegetable intake, greater energy, protein and vitamin A and C intake in children. Better Knowledge, Attitudes and Practices in mothers.
Vietnam ^B (Ngu et al., 1995)	Promotion of homestead gardens with a focus on VA-rich crops. Nutrition education for mothers	Pre-post	Clinical eye signs of severe Vitamin A deficiency decreased to almost zero implying improved vitamin A status	Per capita vegetable production increased 5 fold and increase in intake of energy, protein, and fat.

(Reviewed by Ruel (2001) and Berti et al. (2004)

*=case study intervention; ^R= Ruel review; ^B= Berti review;

Abbreviations: NA=not available; HH=household

The Ruel review published in 2001 found that the interventions that did not include a nutrition education component (generally those conducted prior to the mid-1990s), failed to achieve significant impacts on nutritional outcomes. Subsequent interventions that incorporated education, social marketing, and mass media campaigns together with homestead garden initiatives did demonstrate impacts. The main conclusion of the review is that homestead gardening combined with effective promotional and educational interventions have the potential to improve the nutritional status of populations – but that homestead gardening alone is much less likely to improve nutrition. The review also emphasizes that using a gender-sensitive approach to agricultural interventions could strengthen their impact on nutrition.

The review published by Berti and colleagues in 2004 used a Sustainable Livelihoods Framework to assess whether different agricultural interventions invest in different types of capital: human, physical, social, environmental, and financial. Interventions that invest more broadly in various types of capital, as is usually the case with homestead gardening programs, tended to have a greater impact on nutrition than those that focus more narrowly on agriculture. The authors concluded that agricultural interventions are most likely to be successful if they consider gender, incorporate nutrition education, and invest in natural, physical, social, human and financial capital.

The 2001 and 2004 reviews led to a common conclusion that the success of homestead gardening projects after the mid 1990s could be largely attributed to the projects' human capital-related components. These included communication and nutrition education activities that target behavior change among their audiences, and the incorporation of gender considerations in project design. Nutrition education is a powerful tool. Block (2003) demonstrated that nutritional knowledge is a key determinant in how household food budgets are allocated. Households with nutrition knowledge allocate substantially larger shares of their household food budgets to foods rich in micronutrients, and are unwilling to reduce consumption when staple food prices increase. This impact is not due to maternal schooling per se, which has been independently demonstrated to improve child nutrition outcomes.

Interventions involving animal source foods. Leroy et al. (unpublished) reviewed fifteen intervention studies on animal source foods, including three on aquaculture, five on dairy production, three on poultry, and three in which livestock production was one component of larger integrated projects. The findings concerning the impacts of these studies on production, income and expenditure, women's status, and dietary intake and nutritional status are summarized in table 4. The studies cover several of the pathways outlined in chapter 2, including increased production of own consumption, income increase, and empowerment of female producers. Most of the studies showed a positive impact on production of animal source foods, despite the large variability of promotional interventions. Similarly, most interventions that measured income or expenditures also reported increases in these indicators. In many cases income increases resulted in higher food expenditures, and in some, the purchase of high-quality nutrient-rich foods.

Impacts on nutrition outcomes showed mixed results. For aquaculture interventions, one intervention may have actually decreased dietary quality because it led to a switch from consumption of small fish (which are consumed whole and contain high levels of calcium and vitamin A) to greater consumption of larger fish with poorer micronutrient density (Roos et al. 2003, Bouis et al. 1998). In another, there were no differences in total

fish consumption between the fish producing and non-fish producing households (Roos et al. 2003). In a third study, intervention households appeared to have consumed more fish, but the analyses were not subject to statistical testing (Thompson et al. 2000).

Similarly mixed results were found for dairy interventions. In one intervention in India, households in villages with milk cooperatives actually consumed less milk than households in villages without cooperatives. The overall nutrient consumption of households with cows in intervention villages rose did however rise, whereas nutrient consumption among non-producing households fell (Alderman 1987). In another, children in households that produced less milk had lower protein energy intake, although none of the groups met their energy requirements (Begum 1994). A third intervention in East Africa found that households with crossbred cows consumed more energy, fat, protein, retinol, and iron than non-adopters while in Kenya, women participating in the intervention reported increased milk consumption (Ahmed et al. 2000; Mullins et al. 1996).

Poultry interventions in Bangladesh and Egypt saw higher intakes of a range of nutrients among participating households than among non-participating households (Galal et al. 1987; Nielsen 1996). Another poultry intervention in Bangladesh did not lead to increased egg or chicken consumption, but participating households did eat more fish, suggesting that the intervention led to increased income and subsequent dietary change (Nielsen et al. 2003).

Table 4: Summary of Intervention Studies on Impacts of Animal Source Food Interventions on Nutrition-related Outcomes

Country/ Reference	Intervention	Design <i>Concern with methods</i>	Production	Dietary intake and nutritional status	Income and expenditure	Women's Status
AQUACULTURE						
Bangladesh Bouis et al. (1998)	Polyculture fish production in household-owned or group-managed ponds (or vegetable production) to improve income; some nutrition education was provided, but primary objective was not better nutrition	Three groups: a. Adopters b. Potential adopters (in non intervention villages) c. Random selection households not in a. or b. <i>Non-random assignment of households to groups</i>	n.a.	No effect on fish consumption; shift to larger fish, i.e. effect on nutritional status may be negative Modest effect through increase in income Preschoolers are favored particularly boys Program effect on nutritional status not estimated	Positive but very modest increase in income	Demands on time relatively small.
Bangladesh Roos et al. (2003)	Poor farmers trained in carp culture. Household ponds were stocked with carp and either <i>mola</i> (species very rich in vitamin A) or other small indigenous fish species (SIS)	Treatment/control - post <i>Unclear selection of households</i> <i>No randomization</i>	No difference in production between <i>mola</i> and SIS ponds	No difference in fish intake between producing and non producing hh 47% of the <i>mola</i> was consumed in the household, covering 21% of the recommended vitamin A intake	n.a.	n.a.
Bangladesh Thompson et al. (2001)	Aquaculture extension (pond aquaculture). Households expected to adapt monoculture of tilapia or silver barb or polyculture of native and exotic carp species using on farm resources.	Treatment/control 2 control groups: neighboring households in same village and others from other area. <i>No randomization, no statistical tests</i>	Both extension recipients and neighbors have higher yields than control farmers	Intervention and neighboring households seemed to consume more fish	Return on investments higher in extension households	n.a.
DAIRY						
India (Alderman, 1987)	Integrating rural households into a market economy by increasing the use of purchased inputs and increasing the marketed surplus Dairy cooperatives were set up in the villages	Treatment/control; Pre/post comparisons of households in villages with and without dairy cooperatives <i>No randomization</i>	Villages with cooperatives produced twice the amount of milk as control group (result of > no. of crossbred cows)	Households in villages with cooperatives consumed <i>less</i> milk The nutrient consumption of milk producing households in intervention villages rose, that of none producing households fell	Income and expenditure increased	n.a.

Country/ Reference	Intervention	Design <i>Concern with methods</i>	Production	Dietary intake and nutritional status	Income and expenditure	Women's Status
India Begum, (1994)	Dairy Development Project of the Indian government; formation of dairy cooperatives	Treatment/Control - post 3 groups within treatment: large (LP) (>5 l/day), medium (MP) (2.5-5 l/day) and small producers (SP) (<2.5 l/day)) <i>No randomization, no statistical testing, no control for confounders, no details on intervention</i>	n.a.	Only children in the LP meet protein RDA LP children have the highest energy intake too (do not meet RDA) Overall, protein and energy requirements best met in LP and worst in MP.	n.a.	n.a.
Ethiopia Ahmed et al., (2000); Tangka et al., (1999)	Market oriented dairying for smallholder mixed-crop and livestock farmers; use of crossbred dairy cows for milk production and traction; farmers with crossbred cows encouraged to grow fodder and received training on improved hygiene and restricted grazing; also veterinary and breeding services.	Treatment/control - post <i>Poor design, no baseline, no control for self-selection bias, no randomization, methodology poorly described, no control for confounders</i>	n.a.	Energy intake 19% higher in participating households; Intake of fat, protein, retinol and iron also higher (Ahmed, Jabbar, and Ehui, 2000)	Income of treatment households 72% higher; Higher income associated with higher food and non-food expenditure (Ahmed, Jabbar, and Ehui, 2000)	No apparent increase in women's labor input Men's incomes benefited significantly more from intensified dairying than women's (Tangka, Ouma, and Staal, 1999)
Kenya Mullins et al. (1996)	National Dairy Development Project: intensive dairy technology through introduction of crossbred cows, fodder production	Before (recall) /after <i>No control for self selection bias; no randomization; baseline data collected by recall, small sample size</i>	n.a.	Increased milk consumption	Increase in HH income Increases in food purchases, school fee payments and book purchases	Higher workload for women Increase in maternal income
POULTRY						
Egypt Galal et al. (1987)	More and Better Food Project Combined activities promoting plant production with animal production (poultry). 47% of poultry farmers were women	Treatment/control (adopters compared to non-adopters) <i>No control for self-selection bias; no randomization; no clear use of statistics,</i>	Increase in poultry production (and in maize, peanut and wheat production)	Iron, total protein and animal protein intake higher in adopting households Prevalence of iron-deficiency anemia dropped in school-aged children during the same time period	n.a.	n.a.
Bangladesh Nielsen et al. (2003)	Participatory Livestock Development Project supporting semi-scavenging poultry production; loans and technical assistance are provided through women's groups.	Treatment/control - post <i>Unclear selection of households, no randomization, small sample size</i>	Egg production significantly higher in adopting households No difference in chicken production	Egg and chicken consumption not different Women and girls in adopting households ate more fish	Egg and chicken sales significantly higher in adopting households	n.a.

Country/ Reference	Intervention	Design <i>Concern with methods</i>	Production	Dietary intake and nutritional status	Income and expenditure	Women's Status
Bangladesh (Nielsen, 1996)	Saving schemes, technical training for poultry rearing and credit programs; project beneficiaries were all women.	Before/after <i>Unclear methodology</i>	Chicken production increased	HH consumption of eggs, chicken, fish, meat and milk increased Frequency of vegetable consumption did not change Grain consumption increased	All reported improved economic conditions Both food and non-food expenditure increased; % income spent on food decreased	Women have gained influence in deciding on the use of income
MIX OF INTERVENTIONS						
Ethiopia Ayalew et al. (1999) Habtemariam et al. (2003) ²	Women focused goat development project without impact on nutrition was expanded to include to interventions to promote vitamin A intake, including nutrition and health education, training in gardening, food preparation and distribution of vegetable seeds; school garden clubs	Treatment/control Two treatment groups: local goats or cross-bred goats) No control for self-selection bias	All of the newly started vegetable gardens during intervention period in participating households Participation significantly associated with vegetable garden ownership No other data on production	Goat owning households consume all produced milk 87% by adults as <i>hoja</i> ³ ; children in participating households had slightly more diversified diet; more likely to consume milk >4x/week Participating households consumed egg yolk at low rate (.46/wk) but significantly more than controls (.29) No impact on child anthropometry; clinical vitamin A deficiency lower in intervention children	n.a.	n.a.
Vietnam English et al. (1997)	Fish ponds Livestock Home gardens Nutrition education	Treatment/control After <i>Only 1 intervention and 1 control, village no randomization</i>	Larger production of fish, eggs, vegetables and fruits in treatment community	Children in treatment group had greater intakes of vegetables, fruits, energy, protein, vitamin A and iron, and better child growth		n.a.
Thailand (Smitasiri and Dhanamitta, 1999)	Promotion of poultry and rabbit raising and home gardens through a community based intervention; nutrition education; school-based nutrition program targeted to 10 to 13-year- old schoolgirls; girls received weekly iron supplement of 60mg ferrous sulfate; improved school lunches; poultry raising, fish ponds	Before/after Treatment/control	n.a.	Increased intake of vitamin A in both intervention and control groups, but greater in intervention group Inconsistent findings for iron intake No increases in fat intake Schoolgirls had improved serum retinol and serum ferritin	n.a.	n.a.

Country/ Reference	Intervention	Design <i>Concern with methods</i>	Production	Dietary intake and nutritional status	Income and expenditure	Women's Status
Bangladesh, Nepal, Cambodia HKI Jan2003, May 2004, Nov 2004, Dec 2006	Integration of animal components into existing gardening activities: poultry and eggs in all countries, milk and fish in Bangladesh Nutrition education targeted to women, nutrition improvement targeted at preschool children	Before/after , including quarterly monitoring data - Cambodia, Nepal Bangladesh, before and after, includes control group, quarterly monitoring data.	Cambodia, Bangladesh – median number of eggs produced increased	HH chicken liver consumption increased Proportion of liver from own production increased (Nepal, Cambodia) Increase in egg consumption (Bangladesh, Cambodia) Children in project area consume double eggs per week compared to rural Bangladesh	In Bangladesh, Cambodia and Nepal: 30-66% of income from selling poultry used to purchase food. Additional food purchased in Cambodia 55% fish, 8% beef/pork In Bangladesh additional income used to purchase milk, fruit and fish.	Program in Chars of Bangladesh targeted to women. Endline data show more women's engagement in decision making on household expenditures.

Source –Adapted from Leroy et al 2007 including notes to table. Additional material in table for HKI interventions in Bangladesh, Nepal and Cambodia.

¹ Charles Nicholson, personal communication

² Traditional tea made often of coffee pulp and leaves and preferably drunk with milk (Habtemariam, Ayalew, Habte et al., 2003).

³ Could not obtain original report: Tilden R. Impact of the FAO vitamin A nutritional improvement project in rural Vietnam on: rates of xerophthalmia, nutritional status, maternal attitude and practices, household production and consumption patterns, and children's dietary practices. Rome: FAO, 1993.

Three of the interventions focusing on animal source foods incorporated nutrition education and were combined with fruit and vegetable production (see “mixed interventions” in table 4). In Ethiopia, children in participating households had slightly more diverse diets and were significantly more likely to drink milk four or more times a week (Ayalew et al. 1999; Habtemariam et al. 2003). In Vietnam the intervention group had higher intakes of vegetables, fruits, energy, protein, vitamin A, and iron, and exhibited higher growth rates among children (English et al. 1997). It is not clear whether the animal production caused the positive effects, as the interventions were multi-factorial. In Thailand, Vitamin A intake increased in both intervention and control groups, but the increase was greater in the intervention group (Smitasiri and Dhanamitta 1999).

Leroy concluded that the interventions associated with marked improvement in dietary intake and nutritional status had two key characteristics: women either played a critical role in the intervention, or the interventions included a nutrition education component. The conclusion was consistent with those of earlier reviews, such as Ruel (2001). The only well-conducted study to contradict these conclusions was that on the dairy cooperatives in India during the 1980s (Alderman, 1987).

The authors note that an important question only partially answered in the reviewed studies was whether the reported increases in consumption were a direct effect of increased production or an indirect effect of increased income. For example, Alderman (1987) found that the increased nutrient consumption of milk producing households was not due to an increase in milk consumption, and so was likely to have come through the income pathway.

GENDER OUTCOMES OF AGRICULTURAL INTERVENTIONS

The role of women farmers in general has received much attention in the last few decades. In 1995 the UN Food and Agriculture Organization estimated that women provide more than half the labor required for food production in the developing world, and that this proportion is even higher in Africa. This is important from a nutritional perspective because it is known that women’s status is critical to improved nutrition outcomes.

Yet women farmers face a series of constraints that limit their potential as agricultural producers and their control of the resources that flow from the adoption of new technologies. The constraints are well-documented, and include weak land rights, limited access to common property resources, lack of equipment and appropriate technology, limited contact with agricultural extension, lack of access to credit, and lower levels of education (Quisumbing et al. 1995). All of these constraints conspire to substantially lower the productivity of women farmers, resulting in high opportunity costs for households and communities (Alderman et al. 1995; Quisumbing et al. 1998).

Efforts to ensure that women benefit from agricultural development interventions can be broadly classified into three types of approach: “women-only” projects; projects targeted to both women and men but with some resources allocated specifically for women; and projects in which gender issues are fully “mainstreamed.” There is reason to believe that the third approach is the most likely to improve women’s status in a sustainable way (Pena et al. 1996).

Interventions that seek to increase women’s access to or ownership and control of resources are generally quite complex. Failure to understand cultural norms and the gender dynamics within the household can result in unanticipated outcomes. In the Gambia a project geared to increasing women’s rice production was so successful that the land it was

grown on was reclassified internally within the household. This resulted in output from that land being sold by men as opposed to women. Women therefore lost their original income stream, but did retain an increased labor commitment (Dey 1981). Vegetables and legumes are often regarded as women's crops. Recognizing this, a project in Togo was successful because it promoted the introduction of soybeans as a legume rather than as a cash crop. Promotion as a cash crop would have resulted in the crop switching to male control.

The review of interventions promoting the production of animal source foods that is under preparation by Leroy and colleagues also assessed their impact on maternal income or women's control over income. The results were quite mixed. For example, an intervention involving intensified dairy farming in Kenya showed that an important share of the additional income was controlled by women, whereas in Ethiopia men's incomes benefited significantly more from intensified dairying than women's (Mullins et al. 1996; Tangka et al. 1999). Overall, the review found that whether women's income is likely to increase depends on the livestock or aquaculture production system, the nature of the intervention, and on cultural beliefs and practices relating to gender. Even if the intervention is targeted to women's livestock and aquaculture activities, women may lose control over the income generated by those activities.

The authors also noted that women's livestock ownership rights may not be as stable as men's. In general, stress and constraints lead to an erosion of women's ownership rights, since women's ownership of livestock is often considered a "secondary right." Evidence from around the world shows that the rights of pastoral women and their control over livestock management and marketing are being eroded (Niamir-Fuller 1994).

In conclusion, women's control over income from livestock production activities is very site- and production system-specific. Livestock provides a real opportunity for women to increase their income in some situations. In other situations, however, it merely leads to a significant increase in women's workload without a considerable effect on their control over the additional resources.

SUMMARY

Overall the review documents a wide-range of successful agricultural interventions that have contributed to improved nutrition outcomes. In most cases, however, the exact pathways by which impacts on nutrition have been achieved are difficult to track. This is because studies document impacts on several intermediary outcomes such as food security, income, or women's empowerment, but without directly modeling these pathways of impact to nutrition outcomes. Because these outcomes are so closely intertwined, it is impossible to determine from this literature the relative importance of the different pathways linking agriculture and nutrition.

Over the last thirty years development researchers and practitioners have generated substantial new information and insights into the best strategies for ensuring that agricultural interventions reach the poor, improve welfare, and impact positively on nutrition outcomes. Production is clearly an essential component of these interventions. The nature of the intervention will determine the effect on macro- or micronutrient supply: staple crops for instance can increase energy, whereas animal source foods can increase protein and micronutrients such as iron and vitamin A. But the special challenge of integrated agricultural-nutrition interventions is to translate increased production into increased household consumption and individual intakes.

Agricultural interventions have not always been successful in improving nutrition outcomes. For instance, although all the animal source food interventions reviewed were successful in increasing production of animal source foods, many failed to improve nutrition outcomes. This is because production alone is insufficient to bring about improved nutrition if it does not simultaneously address—or is complemented by other interventions that address—other determinants of nutrition such as improved health and care. Agricultural interventions thus cannot be expected to achieve impacts on nutrition outcomes unless they are integrated with complementary efforts to address other issues like high levels of morbidity and inappropriate child feeding practices.

The review of evidence presented above suggests a number of general lessons about how agricultural interventions can be designed to achieve nutrition-related objectives. Most of these lessons pertain to processes and general approaches rather than packages of specific components, and may be useful in informing planners about considerations to take into account in devising more strategic approaches to nutritional goals. These are worth itemizing before proceeding to the next chapter's presentation of selected case studies.

Follow an integrative process of planning and implementation. Successful interventions usually incorporate both agricultural and nutrition considerations at all phases of planning. Intervention activities should be integrated with other health and development services, and work in partnership with different actors in the field.

Take into account local agricultural and nutrition contexts, and seek opportunities to build relationships with local partners that are intimately familiar with these contexts. Successful interventions often work with local groups and organizations—often non-governmental organizations—that are well-placed to engage and consult with farmers as participants in designing interventions and developing or adapting technologies. These local counterparts can be especially valuable in identifying opportunities to relate the intervention with existing programs, and to integrate intervention components into those programs. These can be important opportunities, and capitalizing on them can yield positive effects on the intervention's sustainability. Successful gardening interventions are an excellent example. Those which have taken into careful consideration traditional gardening practices and the goals and preferences behind gardeners' production decisions have a distinct advantage. By identifying and making available improvements that satisfy gardeners, using the gardeners' own criteria, and accounting for and accommodating gardeners' own priorities, incentives, vulnerabilities, assets, constraints, and livelihood strategies – highly relevant, adaptive, and sustainable changes can be introduced. It also requires a trusting, collaborative relationship between the researcher or project personnel and the participating community, in which the project personnel is necessarily an attentive and sensitive listener, and which the community knows that their concerns have been addressed. Local engagement is also important to ensure that the scope and causes of nutrition problems among targeted groups is accurately identified. The importance of local engagement suggests that investing in pilot studies before initiating large-scale programs and incorporating what is learned on existing conditions, climate, and local culture is a suitable approach.

Mainstream gender. Women play multiple roles in both agricultural production and nutrition, and interventions that consider trade-offs between their respective roles and their time and labor constraints are more likely to lead to positive outcomes. Successful interventions are more likely to take into account the range of factors that differentially

enable or dis-enable men and women in terms of access to resources like land and services like credit. These influence and often determine their roles as decision makers in the household or community. The significance of gender is particularly critical since women's status affects the nutritional status of their children.

Incorporate communication and education components that target behavior change. Interventions that successfully translate increased production into better nutrition outcomes, especially for children, usually incorporate communication strategies that relate the significance of positive or negative behaviors to health and nutrition effects. Information is a vital resource, and households that are equipped an understanding of nutrition- and health-related information display a tendency toward more favorable allocation of food budgets. Raising awareness of the health benefits of a newly available food commodity, one for instance that addresses a prevalent local micronutrient deficiency, may be an important factor in its adoption among producers, including those growing food for their own household's consumption. The importance of educational components is perhaps most pronounced among mothers, whose roles as caregivers extend to other, non-food determinants of nutrition like hygiene and sanitation practices and preventive and curative health. Armed with sufficient information, they are moreover more likely to know when it is necessary to avail household members of health services.

Monitor and evaluate progress. Interventions with sustainable impacts are generally characterized by effective monitoring and feedback loops that enable responsiveness to the shifting realities faced by participants. The nutrition-related objectives pursued by the agricultural intervention will likely remain unchanged, but the factors that act upon that objective may very well be in flux. Changing livelihood strategies may be a particularly important set of developments to track, and here too, monitoring is likely to benefit considerably from good rapport between project personnel and participants.

Taken together, these lessons show that agricultural interventions are most likely to impact on nutrition outcomes when they involve diverse and complementary processes and strategies that redirect the focus beyond agriculture for food production, and towards broader consideration of livelihoods and optimal intra-household use of resources. Successful projects are those that invest broadly in improving human capital and sustain and increase the livelihood assets of the poor.

4: CASE STUDIES

The four case studies of agricultural interventions presented in this chapter were selected for a number of reasons. None have been reviewed before, and they provide insights on new approaches to the agriculture-nutrition nexus. The first focuses an intervention involving the new approach of biofortification. Another incorporated fruits and vegetables together with livestock and may very well be the sole example of an agriculture-nutrition intervention that was scaled up from the community to the national level – and ultimately replicated in other countries. All four interventions explicitly aimed to integrate agriculture and nutrition during planning and implementation, documented agricultural strategies and quantitative diet or nutrition outcomes at the individual level.

ORANGE-FLESHED SWEET POTATO PRODUCTION AND VITAMIN A DEFICIENCY IN KENYA AND MOZAMBIQUE

Background. The first case study provides new insights into the use of a new technology, biofortification, as a nutrition-focused agricultural intervention. Staple foods interventions are generally not viewed as direct routes towards improving nutrition outcomes. This is particularly true in the case of primary staples like rice, maize, wheat, and cassava, which are good sources of energy but not of bioavailable micronutrients. Biofortification, the process of breeding food crops that are rich in bioavailable micronutrients, is attempting to overcome this limitation. One biofortified staple crop – orange-fleshed sweet potato (OFSP) – is already being widely disseminated, particularly in Sub-Saharan Africa. Unlike most staple crops, even unimproved OFSP is rich in vitamin A and efforts to biofortify OFSP have included selection and breeding for still higher concentrations of the vitamin A precursors known as carotenoids.

OFSP has been selected as a focus crop in a number of efforts to improve vitamin A intakes, including the Vitamin A for Africa (VITAA) partnership and the HarvestPlus biofortification program. OFSP is promising for a number of reasons. It contains very high levels of carotenoids, it is well accepted by the young children who are usually targeted, it is easy to cultivate, vegetatively propagated, and fairly drought-resistant once established. It is also a good source of energy for children and adults. Together these qualities make OFSP an excellent food security crop. It is also less labor intensive than most other staple crops, and this is particularly helpful to labor-constrained households such as those affected by HIV/AIDS. It can be planted over a broad range of time without considerable yield loss, and can fill some seasonal gaps in energy and vitamin A intakes. Finally, prices are generally low enough that families will choose to keep some OFSP for home consumption, rather than selling all they produce.

This case study reports on the results of the “Towards Sustainable Nutrition Improvement Project” in Mozambique. (Low et al. 2007a; Low et al. 2007b; Low et al. 2005). The project purposefully built on lessons learned from an earlier OFSP intervention project in Kenya (Hagenimana et al. 2001).³ Box 2 presents a summary of the program characteristics and set of interventions and lessons learned.

³ Project website: <http://aec.msu.edu/fs2/tsni/index.htm>.

Box 2: Introducing Orange-fleshed Sweet Potato in Rural Mozambique

Context. A two-year intervention research project in drought-prone areas of Zambézia Province in Central Mozambique. The area is characterized by high levels of young child malnutrition, a monotonous diet with cassava as the primary staple, and a very poor resource base. Vitamin A deficiency is highly prevalent in rural Mozambique and in the study area (58% at baseline). White-fleshed varieties of sweet potato (WFSP) were already widely cultivated and consumed in the area.

Program model. The following three related elements – each necessary and none sufficient alone – were addressed in order to increase intakes and improve child serum retinol:

- Increase farmers' access to improved orange-fleshed sweet potato (OFSP) vines and roots
- Increase nutrition knowledge and create demand for OFSP
- Ensure sustainability through market development

Interventions:

- Farmers received free OFSP vines via farmers' associations (as per government extension practice at the time).
- Demand was stimulated through multiple communication channels: community theatre and radio spots and visible presence at local markets, as well as nutrition extension.
- Integrated agricultural and nutrition extension services reached 718 women farmers and 323 men. Extension supported production, storage, processing, commercialization, and marketing to create demand.
- Nutrition extension aimed to improve infant and young child feeding practices using OFSP as one input.
- A grading/pricing scheme was developed in partnership with a trader, rewarding quality.
- Several processed products were developed and marketed ("golden bread" and OFSP juice).

Year 2 results and impact:

- 90% of intervention households produced OFSP (vs. 11% controls); of these 30% sold OFSP
- Mean sweet potato plot size increased more than 10-fold in intervention households
- Agronomic performance was acceptable, with yields similar to WFSP
- OFSP was the cheapest source of vitamin A (per retinol unit) in local markets
- Intervention children were 10 times more likely to eat OFSP frequently
- Vitamin A intakes among intervention children were 8 times higher than controls; energy intakes and intakes of several other micronutrients were also higher
- Prevalence of low serum retinol among young children decreased from 60% to 38% (no change in control communities) (Low et al., forthcoming).

Lessons learned and questions for the future:

- Free vines meant farmers had limited incentive to preserve vines for planting next season; sustainability depends on ability and willingness of farmers to invest in improved vine conservation and multiplication, and/or willingness to pay for vines.
- The extension package was relatively intensive; more operational research is needed to identify the lowest cost and most cost-effective package of interventions that can achieve public health impacts.
- Further research is needed to determine if adoption of OFSP is sustained without continual input on demand creation side.

Sources: the Towards Sustainable Nutrition Improvement webpage: <http://www.aec.msu.edu/fs2/tsni/index.htm>, accessed February 27, 2007; (Low et al. 2007b; Low et al. 2007a)

Project partners included: Michigan State University; the Nutrition Division of the Ministry of Health, Mozambique, World Vision Mozambique, the National Institute for Agronomic Investigation (Mozambique), the Southern African Root Crops Research, and Helen Keller International. The project was funded by the Micronutrient Initiative, the Rockefeller Foundation, the United States Agency for International Development, and HarvestPlus.

Assessing impact. Evaluation design and data collection. The evaluation employed a prospective, quasi-experimental design. The objective was to measure the impact of the intervention on children's vitamin A status (using serum retinol) and to document changes in the intermediate factors leading to the nutritional impact, i.e. changes in knowledge, OFSP production and consumption, and vitamin A intake). Three districts were purposefully selected. Within districts, villages were stratified by distance to services and other characteristics and randomly selected within strata. Within villages, all households with age-eligible children were invited to participate; in intervention areas, study participation also entailed participation in local farmers groups. A series of nine surveys were undertaken. Information was gathered on socioeconomic and demographic characteristics of households, agricultural production, child morbidity, adult and child anthropometry, parental nutrition knowledge, food frequency, dietary intakes, and biochemical indicators. In addition sweet potato plots were measured annually and market prices were monitored monthly.

Impact Results. The evaluation showed a marked decrease in vitamin A deficiency among intervention households, from 60 to 38 percent. This was accompanied by significant changes in several of the intermediary factors along the impact pathway, i.e. large increases in production of OFSP, and positive changes in knowledge about vitamin A, and child intake of vitamin A.

Strengths and limitations of the evaluation. The primary strengths of the evaluation component lay in the prospective design, and in the comprehensive series of surveys which documented a wide range of intermediate as well as final outcomes. The main design limitation was that participation in intervention areas was restricted to those willing to join farmers' groups, which precluded a full exploration of determinants of adoption. This also raised the possibility of a self-selection bias, but this threat to internal validity was addressed in the analysis. In addition, the time frame did not allow an assessment of sustainability. Finally, this pilot project was relatively small. Nevertheless, the study results provide "proof of concept" and support the relevance and the potential for impact of the larger VITAA, biofortification, and other efforts.

Innovations. The project took several steps to ensure effective implementation and to maximize the potential for impact of this innovative agriculture and nutrition intervention. Key features of the project planning and implementation, which are believed to have contributed to its success include the following:

- Integrated agriculture and nutrition components at every stage of planning and implementation
- Established links between researchers and communities, through implementing partners
- Identified and selected nutrient-dense varieties that *also* addressed the needs of farmers and the preferences of consumers
- Were grounded in thorough knowledge of context
- Gave due consideration to the roles of women and the constraints they face as farmers
- Included strong nutrition education and demand creation components, using multiple channels and targeting multiple audiences

- Addressed sustainability through efforts to develop local markets for OFSP
- Employed quasi-experimental evaluation design and gathered detailed data on intermediate outcomes to enhance assessment of impact

LEGUME SYSTEMS AND CHILD NUTRITION IN MALAWI

Background. The second case study highlights the potential for a crop often overlooked as a nutrition-focused intervention: legumes. Legumes do not provide extremely high quantities of any individual micronutrient. But they are good sources of a range of macro- and micronutrients, and substantially improve the quality of grain/root/tuber-based diets, for both young children and other family members. The incorporation of legume plant residues can improve soil fertility and potentially increase future harvests. For these reasons, interventions involving legume systems are being implemented by a variety of organizations.⁴ Within the health sector, a number of nutrition education interventions have aimed to increase young child intakes of legumes. Yet there are very few documented examples of agricultural interventions that focused on legumes and that also recorded impacts on individual diets or nutrition outcomes. One such study is the Soils, Food, and Health Communities Study (SFHC) in northern Malawi Soils Food and Health Communities Project (Bezner Kerr and Chirwa 2004; PATH Canada 2004; Bezner Kerr 2006).⁵ The SFHC study explored whether a legume system intervention could improve soil fertility, food security, and child nutrition (Bezner Kerr 2006; Bezner Kerr and Chirwa 2004).

Assessing impact. Design and data collection. The SFHC project was designed as a participatory research project introducing legume systems and using an ecosystem framework to examine the systems' links with food security and health. Project documents identify "monitoring change" as an objective, and the wide range of research activities undertaken were not necessarily designed to measure and attribute impacts. Nevertheless, some study elements incorporated a quasi-experimental approach, including the use of random sampling for quantitative surveys in intervention and comparable control villages over the life of the project. In total, 24 research activities were undertaken between 2000 and 2004, including focus group discussions, semi-structured interviews, participatory mapping, indicator development, yield collection exercises, soil and biomass sampling, and quantitative surveys covering dietary intakes, anthropometry, and hemoglobin measurement. The qualitative exercises covered a range of topics including child care and feeding, legume expansion, and the nature of crop residue use and seed exchanges.

Evaluation results. Box 3 summarizes the results of the study so far. One notable success is reflected by the expansion of farmer participation, which grew from 183 farmers in seven villages in the first year to nearly 3000 farmers in 77 villages in the fourth year. This included a relatively high participation by women (Bezner, Kerr and Chirwa 2004). Preliminary results also indicate that the project succeeded in nearly tripling the frequency of legume consumption by young children, relative to controls (PATH Canada 2004).

⁴ See, for example, the Collaborative Crop Research Program at <http://mcknight.ccrp.cornell.edu/projects/index.html>. This program supports several legume systems projects in Africa (Tanzania, Malawi, Mozambique) and Latin America (Bolivia and Ecuador) aimed at improving utilization of legumes and/or child nutrition.

⁵ Website: http://www.healthbridge.ca/food_soil_e.cfm accessed February 27, 2007

Further analyses of child nutrition outcomes, including anthropometric outcomes, are ongoing (P. Berti, personal communication).⁶

Strengths and limitations of the evaluation. Available documentation did not allow an assessment of the evaluation design and sampling. The evaluation's strengths lay in its use of rich qualitative information, which provided insights into the implementation, adoption, and demand for project activities.

Innovations. Like the OFSP intervention study, this project built on a range of lessons from the past. Agricultural and nutrition concerns were integrated from the outset. Gender issues and other social relations were carefully assessed and addressed, nutrition education aimed to ensure impacts on child diets, and a number of research elements did allow some monitoring and assessment of impacts. Strong participatory and qualitative approaches were employed throughout the life of the project. Farmer research teams, comprised of farmers selected by community members, carried out research along with external team members. The methods used to select farmer research team members were designed to ensure representation of less-advantaged community members, thus addressing an important shortcoming experienced by several past efforts in which teams were dominated by men and better-off household members.

⁶ The project is also continuing in a second phase; see the website of HealthBride (formerly PATH Canada) at http://www.healthbridge.ca/food_soil_e.cfm for a project description.

Box 3: Legume Systems in Malawi: Building on Local Knowledge, Improving Nutrition

Context. A three-year participatory research project (intensive case study) in Mzimba District, Northern Malawi. The area is characterized by high levels of young child malnutrition and a monotonous diet with maize as the primary staple. A variety of legumes are grown in the region. Soils are deficient in nitrogen and input use is low.

Program model:

- Human health and nutrition can be enhanced through design of solutions based on ecosystem management.
- Farmer Research Teams (FRT) can be used to test and promote agricultural innovations.
- To achieve nutrition impacts, FRT embrace and emphasize links between legume production and child nutrition in all farmer meetings, trainings and farm visits.

Legume systems tested:

- Maize intercropped with pigeon pea
- Pigeon pea intercropped with soy bean, then rotated with maize
- Pigeon pea intercropped with groundnut, then rotated with maize
- *Mucuna pruriens* (velvet bean) rotated with maize
- *Tephrosia vogelii* intercropped with maize

Process/qualitative results:

- Participation increased rapidly from 183 farmers (year 1) to nearly 3000 farmers (year 4)
- Participating farmers developed indicators and assessed legume systems with regard to effects on soil fertility, food security, child nutrition, and gender and other social issues
- Farmers' motivation for adoption was to provide family food, not to enhance soil fertility or to sell
- Choice of legume systems reflected their role in filling seasonal food gaps
- Legume system "best" for soil fertility had many undesirable qualities (very long cooking time, need to bury residue during busy season) and was not adopted
- FRT were overwhelmed in year two, leading to development of village committees to support FRT
- Majority of committee members were women, who cited link with child nutrition as their motive for joining
- Men were reported to make decisions about crop use and sale, but in fact women retained some control over both
- Discussions of gender role changes met with resistance from men and grandmothers, but a focus on child health served to "neutralize" conflicts

Sources: Soils Food and Health Communities Project webpage: http://www.healthbridge.ca/food_soil_e.cfm accessed February 27, 2007; (Bezner Kerr and Chirwa 2004);(PATH Canada 2004)

Project partners included PATH Canada, the Ekwendeni Mission Hospital and the Farmer Research Teams. The project was funded by the International Development Research Centre (Canada).

INTEGRATING HOMESTEAD GARDENING AND PRIMARY HEALTH CARE ACTIVITIES IN SOUTH AFRICA

Background. The third case study focuses on yellow fruits and vegetables, including dark green leafy vegetables in South Africa, and is a useful example of an agricultural intervention that explicitly partnered with the health sector. The pilot study was implemented in 1999 in a rural village in Kwazulu-Natal, South Africa, to promote the production of these crops at the household level. The project effectively linked an agriculture intervention with a set of health sector activities to stimulate greater consumption of the products. The intervention package included both an agriculture intervention and a health-nutrition intervention.

Agricultural intervention. The project provided a course on the theoretical and practical aspects of vegetable production such as soil preparation, fertilizers, planting and sowing

dates, plant spacing, irrigation, crop rotation, cultivar choice, weeding, maintenance, pest and disease management, and harvesting (Faber and Benade 2003). Homestead gardens were present prior to the intervention and included traditional gardens crops such as cabbage, maize, vitamin A-rich pumpkin, and *imifino* (a collection of dark-green leaves). A total of nine demonstration gardens were established with the following crops: butternut squash, carrots, orange-fleshed sweet potatoes and spinach, along with a papaya tree. These crops were new additions to the gardens but were already familiar to communities in the area through their availability for purchase in local markets (Faber et al. 2002a).

Health-nutrition intervention. In 1995 a community-based growth-monitoring program was established in partnership with the health sector. The program is a primary health care activity run by nutrition monitors through home-based centers known as *Isizinda*. The project was able to engage the *Isizinda* as a focal point to promote the local production and consumption of provitamin A-rich foods. They also served as agricultural demonstration and training centers, and as nutrition education centers providing instruction on the relation between vitamin A and health, the identification of vitamin A-rich foods, and cooking methods. Vegetables produced in the demonstration gardens were cooked at the *Isizinda* on days when child growth was monitored (Faber et al. 2002b).

Assessing impact: Evaluation design and data collection. Serum retinol concentrations of 165 children aged 2-5 were collected at baseline and their food consumption was recorded during a cross-sectional survey covering the intervention village. A neighboring village served as a control village. One year after implementation, the mothers of a convenience sample of one-hundred 2-5 year old children (50 from households with a project garden and 50 from households without a project garden) were interviewed. Data collected included food intake from 24-hour recalls. A cross-sectional survey was also organized 20 months after program implementation where serum retinol concentrations of 221 children (110 from experimental village and 111 from control village) were measured, along with information on dietary intake and growth of the children, and maternal knowledge on vitamin A.

Results of the one year follow-up revealed that dietary vitamin A intake increased significantly in children from households with a project garden, and to a lesser extent in children from households without a project garden. 20 months into implementation results revealed that after the onset of the intervention, the number of project gardens gradually increased to reach a total of 126 gardens (including demonstration gardens). Only 8 percent of the households with project gardens sold some proportion of the produce for cash. Between baseline and 20 month follow-up, there was a significant increase in maternal knowledge scores in the experimental village compared to the control village.

At the same time, significantly more children in the intervention village than in the control village consumed carrots, pumpkin or butternut squash, spinach, and *imifino* – all vitamin A-rich foods. From baseline to follow-up, serum retinol concentrations increased significantly in the experimental village and decreased significantly in the control village. At follow-up, children from the intervention village had higher serum retinol concentrations than children in the control village, while the reverse was true at baseline. Among the children in the experimental village, those from households without a project garden had significantly lower serum retinol concentrations than did those from households with a project garden, and their concentrations were similar to those of children from the control village. Since all households in the intervention village were exposed to the same

nutritional education and agricultural demonstration sessions regardless of whether they had a project garden, the finding above suggests that access to supply was critically more important than was education without ready access.

Strengths and limitations of the evaluation. The home gardening program had a positive effect on serum retinol concentrations, habitual intake of targeted garden crops, and maternal knowledge regarding nutrition. In addition, villagers appreciated the fact that they no longer had to buy vegetables and recognized the health benefits apparent among their children. The evaluation did however have several weaknesses. The treatment and control groups were not randomized and the effect of the intervention was assessed using a cross-sectional survey comparing households with and without gardens. Self-selection of households (i.e. participating or not in the garden project) was not controlled for and for logistical reasons, the evaluation survey was done at the beginning of the new growing season for many crops (20 months), when mostly spinach and carrots are available. Had the evaluation been conducted at 24 months, then orange-fleshed sweet potatoes and butternut squash would have been in abundance. It is likely that the effects on consumption and nutritional status would have been even larger.

Innovative features and success factors. The success of this project appears to be attributable, at least in part, to successful coordination among multidisciplinary groups of agriculturalists, nutritionists, and the community. The inclusion of complementary project components like the primary health care activity (which monitored child growth) and nutrition education likewise also contributed to the project's success. Nutrition and agriculture education were found to be necessary but not sufficient conditions to achieving marked improvements in nutrition. This finding suggests that, at least in this context, food insecurity was a significant constraint to behavior change; and that the collaboration between agriculture and health allowed the synergies between the two sectors to improve nutrition.

HOMESTEAD GARDENING FOR FRUITS, VEGETABLES AND LIVESTOCK IN ASIA

Background. The fourth case study involved homestead gardening for fruits, vegetables, and livestock in Bangladesh and is notable not only for the range of commodities it dealt with, but because it is a rare example of an intervention that was scaled up from the community to the national level, and ultimately replicated in other countries.

Homestead gardening in Bangladesh is a mainly seasonal activity, with about 70 percent of fruits and vegetables being produced in winter. Vegetable and fruit production satisfies less than 30 percent of national demand. In an attempt to gain a better understanding of existing gardening practices, Helen Keller International (HKI) conducted a small assessment in north-west Bangladesh in 1988. Based on the findings, HKI developed a pilot program among 1,000 households between 1990 and 1993. The aims of the program were: (i) to explore the feasibility of promoting low-cost vegetable gardens combined with nutrition education; and (ii) to identify constraints that might prevent increased production and consumption of vitamin A-rich foods among poor households.

The pilot program provided a wealth of information on the successes and challenges of gardening programs in Bangladesh and provided Helen Keller International with the information it needed to expand the program. Among the results were encouraging data suggesting that household production of fruits and vegetables could be possible throughout

the year with some technical assistance and support. A midterm evaluation in 1992 confirmed that the combined homestead gardening, nutrition education, and gender aspects of the program had a very positive impact on vegetable consumption among women and young children. The monitoring and evaluation system of the pilot program also identified challenges that needed to be overcome. For instance households were unable to sustain change without a regular supply of quality seeds and other inputs. Scaling up the pilot would require greater understanding of a number of issues, including cultural beliefs about child feeding, maternal food intake during pregnancy, intra-household food distribution, and the role women play in program activities.

The large quantity of data provided by the pilot program was then used to develop a larger-scale homestead gardening program, including the need for adequate management and human resources to implement a large-scale community program. The pilot study was expanded in collaboration with local NGOs and the government of Bangladesh into the “NGO Gardening and Nutrition Education Surveillance Project” in 1993 (Talukder et al. 2000). Eventually, the program was scaled up to national level coverage, supporting 900,000 households supporting 4.5 million beneficiaries.

Based on the success of the experience in Bangladesh, the project was replicated by Helen Keller International in Cambodia, Nepal, and Philippines and adapted to Niger (Helen Keller International, 2004, 2006). Recognizing that micronutrients like Vitamin A are less bio-available from vegetable sources, HKI began a pilot extension of their home gardening program by integrating animal husbandry in Cambodia, Bangladesh, and Nepal. The incorporation of an animal source food interventions benefited richly from collaboration with a long running, well established program with capacity for nutrition education, production training, and monitoring and evaluation.

Intervention elements and scope. The objectives of the Bangladesh homestead gardening program were threefold:

- to increase the number of households that sustainably produce different varieties of vegetables and fruits throughout the year
- to increase the number of households producing more varieties of vegetables
- to increase consumption of vitamin A-rich foods and improve the nutritional status of the most vulnerable groups

The gardening and nutrition education activities were linked with the ongoing development programs of local NGOs. Strong linkages were established with participating communities to ensure sustainability. The NGOs’ work with women’s groups helped them to address the social and cultural constraints faced by women in Bangladesh. These NGOs were supported financially by HKI for the first three years of the project. The establishment of village-level nurseries and homestead gardens was conducted by the NGOs in conjunction with community groups. The village nurseries served as a community support service network, where demonstrations and training on low-cost, low-risk gardening practices were conducted, and where seeds, seedlings, and saplings were produced and distributed. Most of the village nurseries in the program operated as small enterprises.

Each NGO was encouraged to form 45 village nurseries per sub-district, with a minimum of 800 square meters serving five to ten villages. Five to ten working groups of the NGOs of approximately 20 women each were linked to each nursery to participate in

the gardening program. A group leader or selected individual was identified to develop and manage the nursery. The group leader also facilitated nutrition and health education through peer education among the women's groups. HKI provided training and technical assistance to the agriculturists and extension agents of the partner NGOs, and together with them, provided technical assistance based on the needs of the households and nursery owners. This technical assistance was designed to reinforce and improve existing positive gardening and consumption practices.

Program monitoring was an essential part of program implementation and was particularly important in scaling up. Monitoring was used to identify problems and priorities and develop solutions based on sharing between the beneficiaries and the program staff. In addition to the monitoring of program activities, HKI staff regularly supervised NGO field and management staff. By implementing the program in partnership with NGOs, households continue to receive technical support for homestead gardening, and the program continues to expand without input and resources from HKI.

Gender was an important focus of project activities. Women in rural Bangladesh have traditionally managed seasonal homestead gardening, from sowing to harvesting and storing seeds. Thus the program actively targeted women in an effort to provide them with new opportunities to generate income related to homestead gardening. Women are also generally responsible for procuring and preparing food for their children. It is estimated that at least 90 percent of the targeted households are represented by women.

To incorporate animal source foods into the intervention, model farms were established with existing village nurseries. The animal source foods of focus were poultry in Cambodia and Nepal and poultry, milk and fish in Bangladesh. Each model farm supported a number of households with training and support for household poultry rearing, including improved breeding stock, chicken management services. Nutrition education focused on dietary diversity, micronutrient consumption and maternal and child nutrition (HKI 2003). In Cambodia the village level poultry farms were owned by village farmers and run as micro-enterprises.

Assessing impact. Evaluation design and data collection. The NGO Gardening and Nutrition Education Surveillance Project used an integrated monitoring system to provide regular feedback on program progress. The data was collected on a regular basis using a simple questionnaire on seed production, vegetable and fruit production and consumption, and income. In addition, a cross-sectional survey was conducted in February and March 2002 to evaluate the economic and social impact of the program on its beneficiaries and the sustainability of the program.

This evaluation comprised three groups of 720 households each, totaling 2,160 households, representing active program participants, former program participants, and control households. Structured questionnaires were used and data on homestead garden production was estimated in kilograms by the homestead caretaker. Additional information was collected on the adoption of year-round production practices, consumption levels of garden produce, the amounts of cash generated, changes in the ability of women to contribute to household livelihoods, and other developments.

Evaluation results. The program increased the production and the consumption of fruits and vegetables in the areas it covered and increased the number of varieties consumed. Monitoring showed that the percentage of households without a homestead garden decreased from 25 percent at baseline to less than 2 percent after one year (Talukder et al.

2000). After one year of participation in the program, the percentage of households who practiced year-round (developed) gardening had increased significantly from 3 to 33 percent. The number of varieties and the volume of vegetables produced in developed gardens were three times higher than those using traditional gardens. The cross-sectional evaluation conducted in the winter of 2002 revealed that households participating in the project produced a median of 135 kg of vegetables and 24 kg of fruit in the preceding 3 months, compared to 46 kg of vegetables and 14 kg of fruits during the same period for control households (Bushamuka et al. 2005).

Results also revealed that children in households with developed gardens consumed 1.6 times more vegetables. Among children aged 12-59 months who had not received a vitamin A capsule in the six months prior to the survey, the risk of night blindness was lower when their house had a homestead garden. Thus, having a homestead garden appeared to reduce the need for vitamin A supplementation.

73 percent of the gardens were managed by women, and women were the main decision makers regarding gardening practices and use of the income earned by selling garden produce (Talukder et al. 2000).

Households earned on average the equivalent of US\$8 on a bi-monthly basis by selling the fruits and vegetables. The main use of this income was for food and also to invest in seeds, seedlings, saplings, poultry, or other income-generating activities. Nearly 10 percent of households saved income generated from the garden. Results also revealed that households with improved or developed homestead gardens consumed micronutrient-rich, non-cereal foods more frequently than other households. These foods such as lentils and animal products are not actually produced in the garden, but were purchased using income generated from the selling of garden produce (Helen Keller International 2003).

Chicken liver is a particularly rich source of vitamin A and other essential micronutrients. In Cambodia and Nepal the percentage of households consuming chicken liver increased from 21 to 35 percent and from 28 to 41 percent among those households consuming it from their own production.

In Bangladesh and Cambodia egg production and consumption increased. In Bangladesh 94 percent of the participant households consumed eggs in the seven days prior to the survey – an increase of 48 percentage points over the baseline. More importantly, egg consumption increased disproportionately among women and children, almost doubling. There were no changes in egg consumption in the control group. Nutrition education emphasized both intrahousehold distribution issues and micronutrient consumption, and focused on the special needs of women and young children.

Strengths, limitations and conclusions. This program is a success story of scaling up of a small scale gardening program. Limited experience exists of successful scaling up of gardening and nutrition programs, and the Bangladesh model is one that has been well documented and has been successfully replicated in several countries in Asia.

The program continues to expand in Bangladesh into new areas and to additional households in the current working areas. The gardening model has been adopted by the Government of the People's Republic of Bangladesh and has become part of a program of the Department of Agriculture Extension. In 1997, HKI started the phase-out of technical and financial support to NGOs that had already received three years of its support. Monitoring information from these areas one year after the withdrawal shows that the

households are maintaining their improved gardening practices and continue to consume fruits and vegetables more regularly.

LESSONS FROM THE FOUR CASE STUDIES

The case studies drew from the experience of many previous interventions. All four employed a nutrition education component directed at behavior change in the participating communities. Each of them also took local contexts into account, built partnerships with different members of the communities to promote ownership, and purposefully involved women and targeted their empowerment.

All four interventions achieved their ultimate objective of improving the intake of focus nutrient-rich foods by target population groups, especially women and young children. The two studies that measured biochemical indicators of vitamin A deficiency also documented a significant reduction in the prevalence of vitamin A deficiency in children. The Bangladesh study documented reductions in night blindness (a clinical sign of vitamin A deficiency) among children of households with a homestead garden. Although none of the studies rigorously modeled the pathways of impact the interventions followed, the marked increases recorded in production, consumption and intake suggest that the direct pathway of consumption of own production was the dominant one. The income pathway was not as consistently documented, thereby preventing a firm conclusion regarding its relative importance across the four case studies. The Bangladesh-Africa study, however, does document an impact on income, which translated into purchasing and higher-quality foods and overall enhanced diet quality and nutrient intakes.

The case studies each made a unique contribution to the current understanding of potential modalities linking agriculture and nutrition and key success factors. The biofortified orange fleshed sweet potato intervention, which resulted in large increases in vitamin A intakes and status, provides encouraging signals for future interventions involving this newly bred crop. The focus on gender in the legume project was highly successful in achieving meaningful increases in legume consumption in young children. In South Africa, the successful partnership between the agricultural and health sectors appears to be responsible for the impacts on maternal knowledge and vitamin A status. That study also underlines the importance of boosting food availability and access through agriculture in contexts where food insecurity is a major constraint to behavior change. In Bangladesh, both the production-consumption-intake pathway and the income pathway seemed to have played a role in improving vitamin A intake and status. The Bangladesh case study is also a unique example of successful scaling up of a homestead garden project, and of the importance of focusing on women.

Earlier reviews had noted the importance of properly designing and conducting evaluations of agriculture and nutrition interventions in order to better document impact and best practices. The case studies reaffirm that careful evaluation design is critical but remains a challenge, since all the methodologies employed had certain limitations. Scaling up also remains a challenge. With rare exceptions, the interventions remain small in scale and unlikely to achieve broad impacts. To scale up agricultural interventions to have a broad and sustainable impact requires their integration into the activities of institutions, both in the agriculture sector and in other sectors whose activities can contribute to improved nutrition outcomes. These institutional issues are dealt with in chapter 6.

5: THE CHANGING CONTEXT OF AGRICULTURE AND NUTRITION

The economic and policy context surrounding agriculture-nutrition linkages is changing rapidly. The changes carry important implications that will affect the ability to carry out agricultural interventions that more effectively improve nutrition outcomes. This chapter examines four types of change that drive behaviors among producers and consumers, and that together are transforming the agricultural landscape and its relationship to human nutrition.

- Agricultural policy
- Agricultural technology
- Food marketing systems
- Food consumption patterns

AGRICULTURAL POLICY

Domestic agricultural and food policies in many developing countries historically assumed an interventionist stance which paralleled and complemented protectionist restrictions on trade. The policies applied principally to staple crops, but extended outward to agricultural products generally, including fruits and vegetables. Government agencies often controlled trade in food products, with laws that severely limited private trading, like restrictions on the purchase or movement of production output by private firms. In the 1970s and 1980s, such interventionist policy regimes often concealed an inherent urban-industrial bias, imposed in part through import substitution, financial sector controls, and overvalued exchange rates that subsidized urban and industrial development by taxing agriculture (Christensen and Witucki 1982; World Bank 1986b; Bhagwati 1993; Delgado 1995; Sanders et al. 1996; Sahn et al. 1997; Teranishi 1997; Badiane 2000; Thorbecke 2000). In the 1970s, several developing countries faced macroeconomic difficulties involving balance of payments problems. In a pioneering work, Krueger, Schiff and Valdes (1991) showed that agricultural sector in many developing countries were taxed by the policies of overvaluation and import substitution. The net taxation of agricultural sector meant that farm incomes were suppressed.

Though the role of the government in food markets continues to be extensive in most developing countries, there are definite indications that the domestic food markets are being liberalized. Additionally, through changes in exchange rate regimes and trade liberalization in the non-agricultural sector, the levels of taxation or “disprotection” of the agricultural sector have declined over time.

Trade liberalization has been a particularly important policy change. Historically, developing country governments restricted international trade in food to limit import competition and prevent export driven increases in food prices. This changed with the culmination of the Uruguay Round and the Agreement on Agriculture in 1994, which resulted in the development of a more open multilateral system on trade in agricultural products. While the pace of reforms would later stall during the Doha Round of the World Trade Organization a decade later, a number of North-South preferential trading arrangements would still come into existence. Preferential trading arrangements have significantly altered the effective trade regime for the agricultural producers in many

countries as well as the availability of products for consumers. Two prominent examples are the European “Everything but Arms” initiative and the US “African Growth and Opportunity Act,” both of which give expanded access to selected low-income countries. Some countries like Bangladesh have also attempted unilateral liberalization. Regional trade agreements have also been developed, increasing at a rate of 15 percent in the 1990s (FAO 2004). These changes have resulted in a rising share of output being traded, as well as changes in the composition of trade. The average tariff on nonagricultural goods fell from around 40 percent in 1947 to 4.7 percent by the end of the Uruguay Round in 1993. Since 1971, global agricultural exports have grown at 3 percent a year in real terms, while agricultural production has grown at 0.7 percent a year. As a result, the share of agricultural production that is exported has doubled, rising from 19 percent in 1971 to 40 percent in 2003.⁷

The liberalization of both domestic and international food markets carries far reaching implications for food prices. It can lead to decreases or increases in consumer prices which can benefit or hurt consumers in general, but the effects tend to be especially felt by poor consumers. Liberalization’s net effect on poor consumers relies on a number of factors, including the price and the importance of each item in the household’s consumption basket and the substitutability of the item with others that are available at reasonably similar cost. At the national level, the impact on commodity prices will vary across commodities depending on whether the country is a net-importer or a net-exporter of that commodity. The distinction is very important for assessment of the much debated impact of multilateral trade liberalization on nutrition security. Highly subsidized agriculture in industrialized countries affects the farmers in developing countries adversely but helps the food and nutrition security of net food importers, especially those that depend heavily on imports. Box 4 presents a synthesis of cases in South Asia that have undergone changes in their trade policies and have experienced different outcomes in food consumption.

Similarly, the impact of trade liberalization on producers depends on whether the sector in question was protected or taxed to begin with. Sectors that were protected before would face greater import competition and could lose out while those that were taxed initially could benefit from new opportunities from trade liberalization. Theoretically, if resources (including labor) could be effortlessly transferred across sectors, then the transition following trade liberalization would be less detrimental to household income, with subsequent implications for food consumption. In reality, the structural features of the developing countries imply that resources are not freely mobile across sectors and those employed in the protected sectors would in fact suffer likely job and income losses due to trade liberalization. When the group of losers from trade liberalization includes a large section of the poor, as may well be the case in many developing countries, then trade liberalization can result in a rise in poverty, at least in the short run. The impact of trade liberalization on nutrition is therefore likely to differ depending on the initial status of the country (as a net importer or exporter) and then within the country across net producers and consumers.

The relationship between trade reforms and food security was explored in a series of 15 country case studies published in 2006, with food security a precondition for nutritional improvement (Thomas 2006). Food security was assessed according to three indicators,

⁷ These calculations are based on FAO statistics for agricultural exports and the World Development Indicators for agricultural value added and the US dollar GDP deflators.

availability, accessibility and stability. Enormous differences in outcomes were observed between the 15 countries, some attributable to the nature and extent of the reforms themselves, others attributable to the heterogeneity of initial conditions. Modest growth in food availability was recorded in Kenya and Malawi while in China per capita supplies of the principal nutrients improved dramatically. In Tanzania, per capita availability of the main nutrients declined following reform. The effects of structural policy reforms on household incomes tend to rely on the overall response of the economy to the reforms. In countries where post reform economic growth was inadequate, poverty was likely to deepen. Overall the study concluded that outcomes related to food security could be worsened in the short to medium term if it is introduced without a policy package designed to offset the negative effects of liberalization – especially for countries in earlier stages of economic development.

Box 4: Trade Liberalization and Food Consumption: Synthesis of Cases in South Asia

There has been a clear improvement in the availability per capita per day of calories and fat in South Asia between 1971 and 2002, though the availability of proteins has improved only marginally. The exceptions are Bangladesh with respect to proteins and Sri Lanka for fat, both of which have remained stagnant over time. In Bangladesh, significant improvements in the availability of calories and fats took place in two bouts, once during the late-1980s and then during the late-1990s. In India, significant improvements in the availability of calories and proteins occurred during the 1980s, while improvements in the availability of fats occurred fairly steadily since late-1970s. Nepal witnessed a similar pattern as India, except that steady improvements in the availability of fats started from the early-1980s. In Pakistan, steady improvement in the availability of all three nutrients is seen over time except for two phases of deterioration in the calorie and protein availability once during 1976 to 1985 and again during the early years of this century. Sri Lanka presents a picture of fluctuating scenario with improvement, stagnation or deterioration for the three nutrients.

Nepal is the only country in the region where food import dependency rose in the 1980s and has remained stable at modest levels subsequently while Sri Lanka witnessed the sharpest fall in the import dependency. But during this period Nepal achieved the highest levels of availability per capita per day of both calories and proteins from levels much lower than the rest of the countries while Sri Lanka has slipped in its rankings in case of calories and fats. Only in Nepal, both availability and consumption of cereals grew faster than domestic production. In Bangladesh, availability and consumption grew at the same rate as production, whereas in India, Pakistan and Sri Lanka, both availability and consumption have grown at a slower rate than domestic production. Underlying the differential rates of growth of production, availability and consumption is the role of stocks and trade in determining availability and consumption.

Could these differences in the nutrient availability across countries of South Asia be explained by the differences in their policy regimes? Did the very policies that helped improve food self sufficiency hurt the household level food and nutrition security? The case of cereals suggests that this could possibly be the case though the relationship between nutrient availability and trade reforms presents mixed evidence from South Asia. Except in Nepal, significant stock accumulation has taken place in all countries through use of price support / buffer stocking schemes. India, Pakistan and Sri Lanka continue to pursue stocking policies vigorously. While Nepal had only a notional buffer stock policy, in Bangladesh the importance of such interventionist domestic policies waned over time.

In terms of trade flows, India from a net importer of cereals turned into a net exporter since the 1990s and Pakistan became a net exporter recently. While net imports of cereals as a percentage of availability declined steadily in Sri Lanka, it has remained more or less stable over time in Bangladesh. Nepal is the only country, which from being a net exporter of cereals in the 1970s turned out to be a net importer since 1980s though the share of net imports in availability is just 1%. Nepal's porous border with its main trading partner India effectively renders its trade regime nearly free despite the low/moderate tariffs that it maintains. Similarly, Bangladesh's border with India is also relatively porous, though to a lesser extent. Whereas, Sri Lanka, an island nation does not have a porous border like Nepal or Bangladesh and hence the tariffs it maintains do perhaps bind its trade flows.

Reforms in these countries started at different points of time. Bangladesh started trade liberalization from early-1980s, India from early-1990s (with little agricultural trade liberalization coming even later), Nepal from early-1990s, Pakistan from 1980s, and Sri Lanka from late-1970s. Matching the changes in trade regimes with the evolution of per capita consumption, in Bangladesh, reforms initiated in the early 1980s seems to have accelerated the growth in per capita consumption. In India, the improvement in per capita consumption occurred primarily during the 1980s, i.e. earlier than the reforms. While there was hardly any change in the 1970s and in the early-1990s, the late-1990s witnessed a decline in the per capita consumption of cereals, in part due to a rise in cereals exports following liberalization that started in the 1990s. In Nepal, the growth pattern of per capita consumption closely mirrors that of India. This is expected given that Nepal is a land locked country and India as its main trading partner, the food price and supply would depend on the situation prevailing in India.

For Pakistan and Sri Lanka, no obvious pattern emerges between trade reforms and per capita consumption of cereals. The decline in per capita consumption of cereals in Pakistan started in the 1970s, even before the initiation of trade reforms in the 1980s, when the decline continued to occur. The 1990s was a period of recovery, and by 2002, the level of consumption per capita was more or less back to the levels in 1971-75. Sri Lanka presents a picture of nearly static consumption per capita over the years, except for a brief rise in late-1970s, followed by a fall in the 1980s to earlier levels. While the 1990s witnessed a small decline in the per capita consumption, the early years of this century has seen a recovery back to the levels that prevailed in early-1970s.

Sources: Ahmad et al. 2006; Chowdhury, Farid and Roy 2006; Jha and Srinivasan 2004; Pyakuryal, Thapa and Roy 2005; Ravi et al. 2004; Weerahewa 2004.

The issue of producer support through agricultural subsidies became a major focus of contention during the Doha round of trade negotiations that began in 2001. To date no resolution of the issue among WTO members has been arrived at. A number of countries maintain systems of agricultural subsidies, OECD countries in particular, where producer support from the respective governments tends to be high. These supports clearly hurt producers in developing countries, but also benefit net consumers.

Trade reforms can lead to changes in relative prices, and the impact on food consumption could be positive or negative depending on which products have higher market access. The observed pattern of trade in which developing countries are net exporters of micronutrient-rich crops implies that consumer prices are higher for those products than the prices that would prevail in a closed economy. The reverse would hold for the supply of macro-nutrients since the developing countries broadly are net importers of grains.

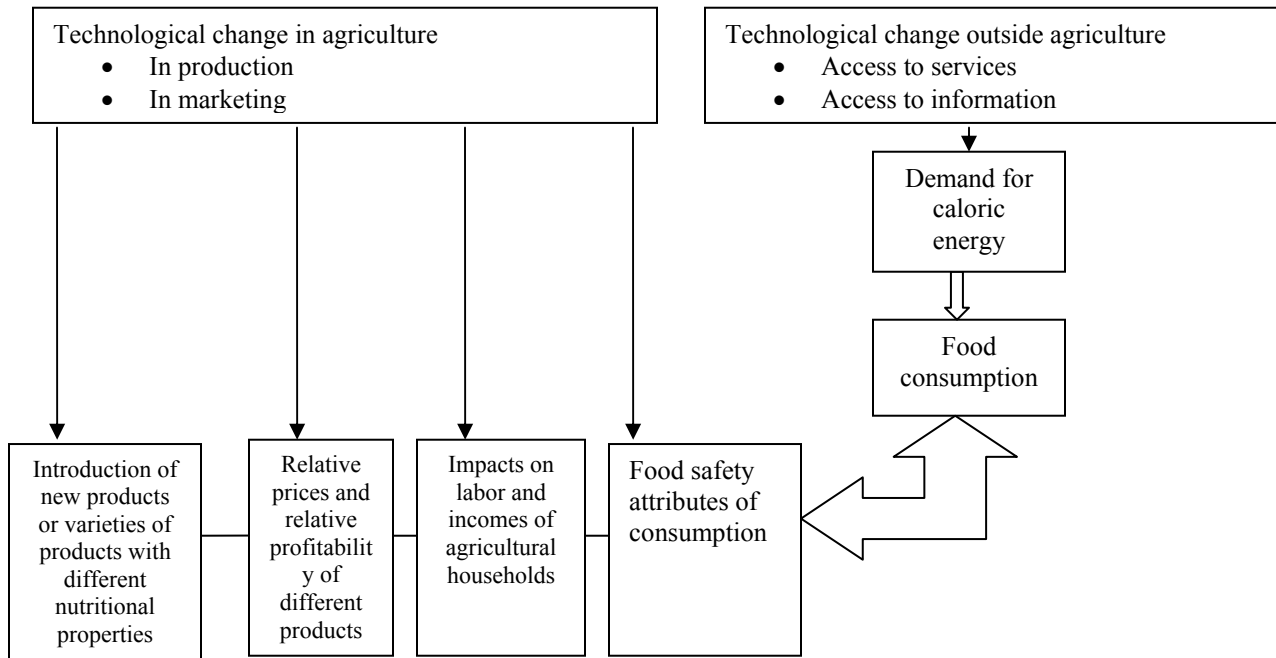
A study by the Economic Research Service of the US Department of Agriculture in 2001 showed that a country's gains from trade liberalization depend on its ability to capitalize on growth in international trade. Global trade liberalization is projected to increase the demand for developing countries' exports. Countries with more diversified agricultural market structures and trading partners are likely to adjust quickly and take advantage of market signals, while countries with weak market infrastructures and those that rely on a few export commodities will find more limited opportunities. The study used a computer model to assess the direct impact of agricultural liberalization on the food security of 67 low-income countries. The methodology used was to compute a nutritional gap comparing projected per capita food supplies with minimum nutritional requirements. The study projected that long run real world food prices would rise by about 12 percent and that developing country exports would increase by about 30 percent following global trade liberalization. These prices when fed into the model showed a reduction in nutritional gaps in the studied countries by 6.4 percent. These gains are relatively modest because of the lack of producer response in developing countries, the declining share of agriculture in total exports, and the small share of food imports in total domestic food availability.

AGRICULTURAL TECHNOLOGY

Agricultural technology has long focused on plant breeding and varietal improvements designed to raise productivity and yields. More recently this technology has also come to focus on the nutrient content of crops and foods generally. Technologies relating to food processing and marketing carry important implications for food availability and patterns of food demand and consumption. Non-agricultural technologies like refrigeration and transport tend to have similar effects, raising the availability of foods through increased shelf life and access to distant markets. Over the last two decades these technologies and the consumption patterns associated with them have spread throughout much of the developing world, most rapidly in areas where incomes are rising. In these areas in particular, technology has wielded an effect on the composition of work that is familiar in the experience of industrialized countries. The effects of technology and technological change on food production and consumption can be classified into four general impacts. The first is the impact on relative prices and on the relative profitability of different products for producers. The second is technology's impact on the labor and incomes of agricultural households. The third is the role of technology in introducing new food products with different nutritional properties.

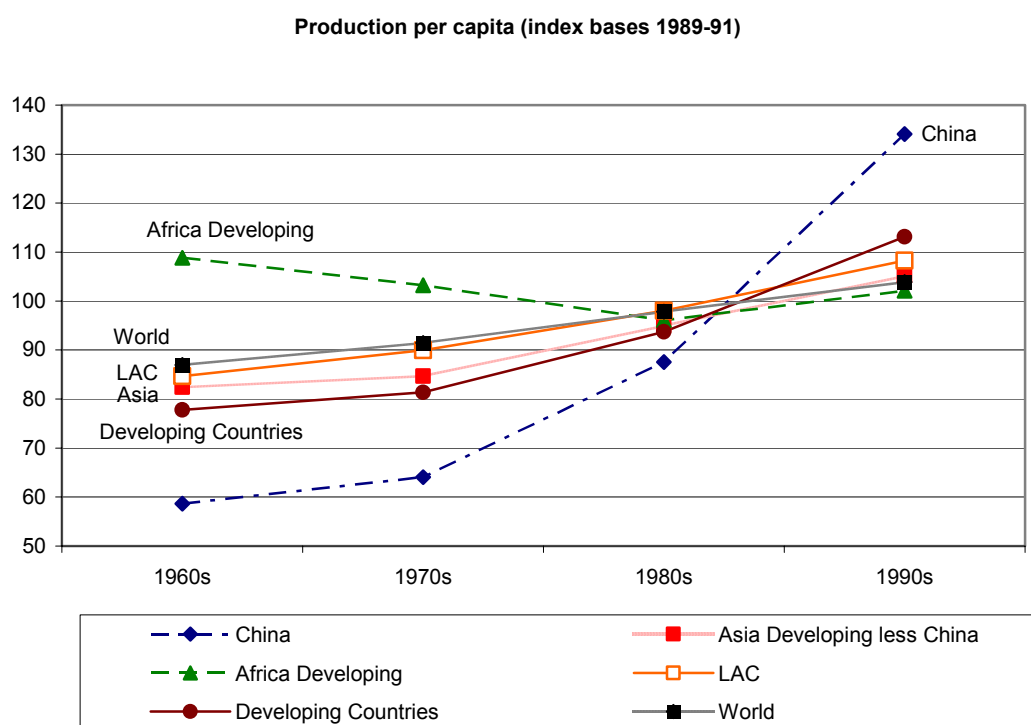
Technology's impacts on relative prices and relative profitability of different products. In the past 50 years, technological change in agriculture has led to spectacular successes, such as the Green Revolution in wheat and rice, and the broad acceptance of single-cross hybrids in maize (Baezinger 2006). Much of the agricultural research and plant breeding undertaken during the Green Revolution took place in public sector institutions and research centers. Recent legal changes, such as the adoption of plant variety protection laws in many countries, have greatly expanded the intellectual property rights of plant breeders. This has gradually shifted the center of research in plant breeding to the private sector and to more market-driven research. It has also made the new technologies developed by that research proprietary, greatly restricting the diffusion of new varieties.

Figure 6: Potential Impact of Technological Changes on Food Production and Consumption



In 2003, a study published in the journal *Science* presented an analysis of the contribution of Green Revolution crop breeding technologies to productivity by crop, region, and by decade between the 1960s and 1990s. The analysis revealed that varietal improvements had occurred at different rates across regions, but that in every region the highest gains from plant breeding were realized during the 1980s and 1990s. The two decades had recorded the highest population growth rates in developing countries and yet productivity gains had led to rising food production per capita. The finding challenged the notion that the Green Revolution was effectively over by that time period (Evenson and Gollin 2003). Figure 7 shows the evolution of food production per capita. With the exception of Sub-Saharan Africa in the 1980s, the production of food per capita shows an increasing trend in most developing countries that was largely attributable to improvements in plant breeding. This implies that the real price of food declined over the 1980s and 1990s, for the world as a whole and for most developing countries.

Figure 7: Changes in Food Production Per Capita over Time



Source: FAOSTAT (Adapted from Diao et al 2005)

Using the IMPACT model developed by the International Food Policy Research Institute (IFPRI), analysts simulated the prices that would have existed without the Green Revolution. The simulated prices were used to calculate the economic availability of food and therefore the impact on food consumption. According to the study, had the Green Revolution not occurred, the proportion of malnourished children in developing countries would have been 6-8 percentage points higher than it is. In South Asia, the percentage would have been 12-15 points higher (Evenson and Gollin 2003). Some products by contrast have seen little or no productivity change, and as a result have risen in price and been removed from many production portfolios. The case of pulses in India, which have seen little if any varietal improvement, sharply rising relative prices, and declining average consumption provides a particularly useful illustration. (Box 5.)

In cases where technology changes the economic availability of food (through changes in relative prices), the extent of impact on prices depends on the kind of technology. For fruits and vegetables, for example, post harvest technology and marketing are likely to play a more important role in reducing prices. Estimates from the Rabobank (2006) conjecture that post harvest losses lead to the spoilage of up to 30 percent of the fruits and vegetables produced in India. Post-harvest losses in fruits and vegetables were as high as 50 percent in Malawi in 2001 (Mwangwela 2001). In such a scenario, improved post harvest technology could lower market costs and consumer prices, and with a significant impact on consumption.

Box 5: Decline in Consumption of Pulses in India: The Effect of Technology and Domestic Policies

Pulses are consumed by almost all categories of households in India. Many consumers in India rely on cereals and pulses as primary sources of protein and calories. This is particularly important in the case of India, where apart from reasons of affordability, many consumers exclude meat for religious reasons. According to Price et al. (2003), stagnant production, a rising population and small imports caused the per capita availability of pulses in India to fall between 1979 and 2001. This is in sharp contrast with the case of rice and wheat, the availability of which rose steadily. The decline in pulses consumption has moreover happened alongside increases in per capita income. This points to the role of the relative prices of pulses and to the availability of substitutes as being the factor behind this trend.

Indeed, index data on wholesale prices in India indicate that between 1980 and 2000, prices for pulses rose significantly relative to other food items. The annual growth rate in pulse prices was 2.1 percent, five times the growth rate in wheat prices and four times the growth rate in rice prices. During the same time period, the annual growth rate in the prices of edible oils and eggs was negative. Consumption data show that with changes in relative prices households exhibit significant substitution towards alternative food products, and to a lesser extent substitution among different pulse varieties.

While several factors have been at play in causing low levels of pulse production in India, the lack of technological progress in pulse production is unquestionably one of them. With regard to trade policy, no other major food item in India has had a consistently more open import regime. Still, pulse imports have been low. Part of the reason is the lack of production of the preferred, low cost varieties by large suppliers like Canada and the US. Moreover, the logistical costs for exporters in these distant countries tend to be high, despite the low tariffs and outright lack of non-tariff barriers.

More importantly, little varietal improvement has occurred in pulses domestically. Yields have remained more or less flat since the 1970s. Additionally, government policies have tended to favor cereals like rice and wheat through support pricing and input subsidies. This has further reduced the acreage under pulses in India.

Source: Price et al. (2003)

Technology's Impacts on labor and incomes of agricultural households. Technological change affects the demand for agricultural labor, and thus the income of farm and non-farm households in rural areas. There are a number of different impact scenarios. As production expands there may be an increase in the demand for labor that positively affects the incomes of landless laborers. Alternatively technological change that leads to more mechanization could reduce labor demand. It is possible that labor-augmenting and labor-saving technologies could be introduced simultaneously, making the impact ambiguous. Technological change may also depress prices and, under conditions of low demand elasticity, negatively affect the incomes of some farmers, particularly those who do not adopt the technology or those who adopt it late.

A 1993 report published by the International Food Policy Research Institute provided a number of such examples in which agriculture – nutrition linkages worked through changes in labor demand. An earlier study published in 1987 had examined households which adopted modern rice varieties in the North Arcot district of Tamil Nadu between 1973 and 1983. The study found that within those households the real value of consumption had doubled during that period, and with a shift towards more varied diets as demand for labor increased during the early phases of the Green Revolution. Subsequent phases of the Green Revolution would see increasing trends towards mechanization and related declines in labor demand (Kennedy and Bouis 1993; Hazell 1987; von Braun and Binswanger 1991).

A number of other studies that examined the income and nutrition impacts of improved varieties found strong relationships between increased incomes and improved nutrition

outcomes following households' adoption of the new technology. Case studies in the Gambia, Guatemala, and Rwanda for instance showed a strong income-to-nutrition relationship, with a 10 percent increase in income leading to a 3.5 to 4.9 percent increase in energy intake and a 1.1 to 2.5 percent increase in anthropometric indicators among children. In other cases the income link was weak. The adoption of new technologies also affected the time and labor allocation of women, which directly affected the degree of improvements in household nutrition outcomes (von Braun and Kennedy 1986; von Braun and Kennedy 1994; Binswanger and von Braun 1988).

In a more recent study, women with the most access to new rice varieties experienced less seasonal fluctuation in body weight, 1.1 kilograms compared to a 2.9 kilogram fluctuation for women with the least access (Kerr 2006). An earlier study of pregnant women in the Gambia indicated that less bodyweight fluctuation between the dry season and the rainy season, combined with an additional 500 calories a day would likely lead to improvements in birth weights (Lawrence, Cole and Whitehead 1987).

The studies cited above dealt with staple crops. For perishable crops like fruits, vegetables, livestock and fish, access to post-harvest infrastructure and affordable technology are likely to be critical in affecting farm incomes. Technological change that improves the productivity of livestock, for example, allows households to diversify from plant-based food into animal-based food, thus improving diets through greater intakes of protein, iron and other essential micronutrients. Adoption of cross-bred breeds of dairy cattle not only raises farm incomes but can also increase the amount of surplus for domestic consumption for the households. At the same time, evidence from India indicates that the shift to more market-oriented dairy production following the adoption of improved technologies like cross-bred cattle could reduce the availability of milk within producing households (Alderman 1987). Often, greater market orientation implies weakening the control of women over milk for the consumption by the households.

Technology and the introduction of new food products. Technology is highly significant for the nutritional properties of foods, including those that are rich in micronutrients. Biotechnology enables the breeding of new crops that are rich in bioavailable micronutrients in a process widely referred to as "biofortification." Fortification also takes place during food processing in the making of products like iodized salt-enriched foods, iron-enriched wheat flour, and vitamin enriched fruit juices. Among wealthier consumers in developing countries, and throughout developed countries more generally, demand for functional foods is increasing. These functional foods are marketed to address particular health concerns and interests among consumers, like reducing the risk of certain diseases and enhancing physiological functions (Roberfroid 2002).

Plant breeding technologies expand the range of crops available for people to plant in homestead gardens as well as the variety of foods available at market. The Food and Nutrition Division of the United Nations Food and Agriculture Organization (FAO) and Asian Vegetable Research and Development Center-Regional Center in Africa (AVRDC-RCA) have been active in this area, and with particular focus on the production and consumption of indigenous, nutrient-rich vegetables. A joint FAO-AVRDC project to reduce vitamin A and iron deficiencies seeks to stagger the production of different varieties of indigenous vegetables, many of which are seasonal, to provide greater continuity throughout the year (FAO-AVRDC 2002). The dissemination of post-harvest technologies that enable farmers to preserve perishable fruits and vegetables will also yield positive

impacts on the continuity of nutrient-rich diets throughout the year, and with considerable importance for income and price links as well as for home consumption.

FOOD MARKETING SYSTEMS

The last 20 years have seen substantial change in the ways that food is marketed. A variety of factors are likely contributing to this change, including rising incomes which induce increased demand for convenience, quality, and food safety. Urbanization, improvements in transportation, and lifestyle changes that see more women working outside the home are likewise significant factors. Advertising techniques now encourage changes in food consumption patterns throughout the developing world (Hawkes 2002). The spread of television has created a strong medium for these messages. Wider ownership of refrigerators and microwave ovens has also changed the content of consumer demand. In most economies the principal drivers of change are the food processing industry, the retail food industry including supermarkets, and the food service industry including restaurants (Minot and Roy 2006). The changes are evident in most developing countries, though they are the most advanced in middle income countries and in urban areas of low income countries.

Food marketing clearly has major implications for agriculture, and the modernization of marketing channels has important implications for farm incomes. Small farmers may be particularly vulnerable. There is a widespread concern that small farmers will be excluded from modern marketing channels owing to the high-transaction costs of monitoring and gathering production from many small producers (Shephard 2005). Multinational supermarket chains also facilitate international sourcing, implying that local farmers must compete with suppliers from other countries. At the same time, they provide a channel through which local farmers may supply stores in other countries. While there is reason for concern regarding the participation of small farmers in modern marketing channels, a number of instances of successful smallholder participation are encouraging. Institutional arrangements such as contract farming have now evolved to link the farmers with the modern marketing channels and this plays an important role in improving their food and nutrition security. The supermarkets and the processors operating at a higher scale and often catering to high-end markets need to secure their supply lines to maintain quality and quantity of inputs or supplies. This has made linking up with farmers an imperative. Contract farming between the downstream firm and local suppliers is becoming increasingly common, and the new linkages being formed between the supermarkets and the farmers show increasing evidence that small producers can participate in supply chains in a manner that enhances their livelihoods (Boselie et al. 2003).

The emergence of new forms of food marketing affects food consumption patterns. The range and mix of products, the promotional efforts and the price of the food all affect consumption decisions. Box 6 discusses how the emergence of supermarkets may affect food consumption through food prices.

Box 6: Modern Marketing Channels and Food Prices

Supermarkets could have the effect of either increasing or lowering food prices. Because of higher efficiency in marketing, the prices of food in supermarkets could be lower. At the same time, there could be a premium on the food prices as a result of the convenience and the standards that the supermarkets provide. Also, if the supermarkets result in higher horizontal integration of the markets leading to market power, then they could exploit the inelasticity of food demand to increase prices (Minot and Roy 2006).

Two empirical regularities here are important for the potential impact on food prices. First, supermarkets have not yet become the supply source for all the consumers in developing countries. There is ample evidence of both supermarkets and traditional retail existing side by side. In many places, the emergence of supermarkets has created a segmented market with the richer sections of the population sourcing their consumption from supermarkets and the low income class from traditional retail. Secondly, in many developing countries including the ones like South Africa where the coverage of retail by the supermarkets is high, there is no evidence for any substantial increase in food prices.

Sources: Kuipers 2005; World Bank 2006.

Food processing. Processing technologies are improving the nutritional content of household consumption through fortification at the same time that some processes involve additives that raise health concerns. The share of processed food in total consumption has also been rising over time. Global sales of processed foods are US\$3.2 trillion, of which about US\$2.0 trillion is spent on packaged food and US\$1.2 trillion on beverages. These global figures are strongly affected by demand in industrialized countries, where consumers spend about half their food budget on processed, packaged foods (Minot and Roy 2006). In lower-middle income countries like Colombia, South Africa, and Thailand, consumers spend about one-third of their food budget on processed food, while in low-income countries like Kenya, India, and Vietnam, the proportion is less than 15 percent (Gelhar and Regmi 2005). In India recent evidence points to a notable shift towards processed foods over time. A demand model developed at the International Food Policy Research Institute (IFPRI) projects that Indian expenditures on processed foods will rise faster than expenditures on both total food and non-food goods (Ravi and Roy 2006).

Food processing also increases the availability of food by reducing post-harvest losses and extending the shelf life of food products. Improved food preservation is enabling developing countries to expand their food exports. One study estimated that processed food exports grew 4.2 percent per year between 1980 and 1994 – twice as fast as primary product exports (Athukorola and Sen 1998). Yet the share of total food exports that are processed has declined in recent years, and the proportion of processed foods that are exported is smaller than the proportion of agricultural commodities that are exported. A number of reasons underlie these limits to trade in processed foods. Processed foods are often subject to much higher tariff protection than unprocessed agricultural commodities. They must meet stricter local standards in terms of labeling and language, as well as meeting specific local preferences for particular product characteristics (Gelhar and Regmi 2005).

Food retail. The growth of large-scale retail outlets, including supermarkets and hypermarkets has been striking in recent years. Among developing countries, their share of the retail food market is highest in middle-income countries such as Brazil, Argentina, and Thailand, and lowest in low-income Asian countries such as Bangladesh and Vietnam. Supermarkets in developing countries are able to handle processed foods and fresh products with a longer shelf-life, but in most developing countries, tend to have a small

share of the market in the fresh fruit and vegetable segment. Table 5 provides some indication of the size and growth of supermarkets in selected developing countries.⁸

Empirical studies also suggest that the price relationship may vary by type of product. Neven et al. (2005) compare prices in Nairobi supermarkets with the prices of similar products in traditional retail. The prices of nine fresh produce items were, on average, 6 percent higher in supermarkets, while the prices of processed food products were, on average, about 3 percent lower. Consumer surveys revealed that the urban poor bought processed foods in supermarkets and fresh produce in wet markets, as would be expected given these price relationships.

A similar analysis was carried out by Ghezan et al. (2002) for horticultural products in Argentina. They find that the prices for fruits and vegetables were, on average, 6 percent and 14 percent higher, respectively, than in traditional retail outlets. However, the average price for all food and beverages was 5 percent lower in supermarkets. In spite of the large market share of supermarkets in Argentina (70 percent in 2000), small fruits and vegetables shops continued to dominate horticultural retail sales. The authors cite survey results indicating that 71 percent of fresh fruits and vegetables were bought from traditional retail outlets.

Food services. The food services industry includes street stalls, fast-food and full-service restaurants, hospitals, schools, and other public places where prepared, ready-to-eat foods are served. On a global level, food service sales are estimated to be US\$1.8 trillion, accounting for some 44 percent of total food sales (Gelhar and Regmi, 2005). The industry comes to account for a far higher proportion of the total food marketed as incomes rise and people work further from home, purchasing meals prepared nearer their workplaces. It has registered rapid growth in many developing countries, particularly those with high rates of economic growth. China is an outstanding example. There, the formal sector restaurant industry alone grew nearly 20 percent a year, doubling in four years.⁹ This growth rate exceeded both per capita income growth and urban income growth in China during the same period. Food consumed outside urban households in China grew from near zero percent in the 1980s to about 15 percent in 2000. Nationally this suggests that spending on food away from home would amount to about US\$15 per person per month in all of China, urban and rural (Gale and Gilmour 2002).^{10,11}

⁸ The data must be interpreted with caution since the definitions of supermarkets and retail sales differ across countries.

⁹ This figure includes only the sales of food service firms that employ more than 40 workers and have annual revenue of more than US\$235,000, thus effectively excluding almost all non-chain restaurants.

¹⁰ This estimate is based on estimates from Hsu et al (2002) that urban food expenditure are US\$236 per person and rural food expenditure is US\$56 per person, the fact that 38% of China's population lived in urban areas in 2000, and the assumption that less than 7% of rural food expenditure is on food away from home.

¹¹ Though the food safety standards in the organized food services industry tend to be good because of reputation effects, concerns exist regarding the quality of food in unorganized street stalls and food vendors.

Table 5: The growth of modern retail in developing countries

Country	Year	Number of supermarkets	Share of super-markets in total food sales	Growth in supermarkets		Information source
				Period	Annual growth rate	
Argentina	2001		57			(1)
Brazil	2001		75			(1)
Guatemala	2001		35			(1)
Mexico	2001		45			(1)
Bangladesh	2004	30	1%	1999-2004	97%	(1)
India	2000		2%	2003-2008	24-49%	(2)
Pakistan	2000	800	10%			(3)
Indonesia	2003	1307	25%	1989-2002	15%	(4), (5)
Philippines	1995	3989	68%	1994-2001	30%	(6)
Thailand	2004	600	54%	2001-2002	11%	(7)
Vietnam	2003	<70	<2%			(8)
China	2003	37,000	30%(urban)	1995-2002	36%	(9)

Sources: (1) USDA, 2004a; (2) Chengappa, forthcoming; (3) SDPI, 2004; (4) Chowdhury et al, 2005; (5) USDA, 2003; (6) Digal and Concepcion, 2004; (7) USDA, 2002; (8) Tam, 2004; and (9) Hu et al, 2004a.

Food exports. The liberalizing trade policy regimes discussed in this chapter have greatly facilitated the expansion of food trade and the development and integration of international food marketing systems, including the extensive supply chains that serve large food retail and service industries. At the same time, applications of food processing and other technologies have enabled food retail and service to both influence and respond to changing patterns of consumer demand. In this environment, the changing commodity composition of international food trade toward higher value products that had already been underway since the 1960s, accelerated. Between the 1960s and the 1990s, grain exports fell sharply from 15 to 8 percent of the total value of agricultural trade (table 6). At the same time, exports of higher value agricultural products such as fruits and vegetables, meat, dairy products, eggs, and fish and seafood grew from 29 to 42 percent of total value. The share of fish and seafood in particular increased from less than 5 percent to over 13 percent of world agricultural trade.

Table 6: Composition of Global Agricultural Exports (% of value)

	1964-73	1974-83	1984-93	1994-2003
Cereals	15.3	16.1	10.8	7.8
Pulses	0.6	0.5	0.6	0.5
Beverages and tobacco	7.8	7.5	9.6	11.4
Animal vegetable oil	3.6	4.4	4.0	4.6
Fruits and vegetables	11.6	10.8	12.9	14.2
Dairy products & eggs	4.6	5.2	5.7	5.6
Meat	8.3	7.9	8.5	8.7
Fish and seafood	4.7	7.0	11.4	13.2
Other	43.5	40.7	36.4	34.0
Total	100.0	100.0	100.0	100.0

Source: FAOstat (2005).

Note: Crop and livestock exports from FAO statistics on primary agricultural products. Fish and seafood exports include both processed and unprocessed.

Animal source foods like livestock, dairy products, and fish, represent exceptionally important sources of protein and highly bio-available micronutrients. Livestock and livestock products represent about one-seventh of the total agricultural trade, but the share is growing over time. Industrialized countries continue to account for the bulk of world trade. Import of livestock and livestock products by developing countries is increasing with the rise being more prominent for dairy products and meat. World dairy trade is small relative to the production, mainly because of the highly perishable nature of the products. Exports of dairy products are dominated by processed items like cheese and milk powder. Even though India is one of the biggest milk producers in the world, international trade in dairy products is dominated by middle- and high-income countries. The potential to improve trade in livestock products are sometimes striking, especially where little marketing infrastructure is required. The case of India and Bangladesh is an excellent example. India has a number of milk surplus regions along the border of Bangladesh, while Bangladesh is milk scarce. Yet no border trade in dairy products exists, however mutually beneficial such trade would be to both countries. Worldwide, the export of fisheries for human consumption grew more than six times between the mid 1970s and 2002, to approximately US\$60 billion. Fish, which is an important source of protein, is still traded much less than its potential owing to its perishability. The within-country trade in fish in most large countries is limited with localized markets dominating.

The composition of agricultural exports has also changed in terms of the share of processed versus fresh products. The share of processed products in agricultural exports increased from 41 percent in the 1980s to 51 percent in the 1990s. The growth in the share of agricultural exports that are processed can be seen in almost all commodity categories. The exceptions to this pattern are fruits and vegetables: both primary and processed fruits and vegetables have increased their share of world agricultural exports over this period, but growth in fresh fruit and vegetable exports has been greater. This reflects consumers' ability and willingness to pay for fresh produce.

FOOD CONSUMPTION PATTERNS

Economic growth, demographic change, urbanization, and global media and mass marketing have stimulated change and diversification in food consumption patterns. The shifting pattern is evident in increasing demand for high-value foods relative to cereals and pulses in most developing countries (Popkin 2006). Dietary changes toward processed and prepared foods are accompanied by changing, generally lower, levels of physical activity as occupations shift to service sector jobs, especially in urban areas. In cities more people work further away from home and eating at a restaurant or food stand is faster, more convenient, and often more economical than shopping for and preparing what are probably healthier meals at home. In these settings, consumers in developing countries come to experience some of the problems as well as the benefits that consumers in industrialized countries experience. This combination of changes to consumption patterns and lifestyle are collectively referred to as the “nutrition transition,” and are closely related to sharp increases in overweight, obesity, and associated chronic disorders like heart disease, hypertension, and diabetes.

Table 7: Average Annual Growth in Global Per Capita Consumption of Various Food Items (%)

Food item	1962-71	1972-81	1982-91	1992-2002	1962-2002
Cereal (excluding beer)	0.5	0.8	0.4	-0.4	0.3
Pulses	-2.0	-1.5	-0.3	0.0	-1.0
Vegetables	-0.3	0.8	1.4	3.7	1.5
Fruits (excluding wine)	1.5	0.5	0.8	1.8	1.2
Milk (excluding butter) and eggs	0.1	0.2	0.0	0.6	0.2
Meat	1.8	1.1	1.1	1.3	1.3
Fish, Seafood	2.0	0.8	1.0	2.2	1.4

Source: FAOStat (2005)

Note: Consumption is measured in kilograms.

Data for fish and seafood is up to 2001

The shifting pattern is evident in the higher growth in per capita consumption of high-value foods relative to cereals and pulses in most developing countries. Per capita consumption of cereals and pulses contracted during the 1990s, while annual vegetable consumption grew 3.7 percent, fish and seafood consumption grew 2.2 percent, and fruit and meat consumption grew between 1 and 2 percent. Regionally, between 1982 and 2002, East and South Asian countries saw per capita consumption of vegetables and fruits rising quickly between 1982 and 2002. Meat, milk, eggs, fish, and seafood consumption grew more slowly, but still increased more than staples consumption. In 2002 East and Southeast Asia exhibited the highest per capita consumption of vegetables in the developing world at 64 kilograms per person per year, and the highest consumption of fish and seafood at 26 kilograms per person per year.¹² Increases in consumption of high-value food products were particularly high in China, where between 1962 and 2002 per capita intake of vegetables grew 4.9 percent, fruit 8 percent, and meat 8.7 percent. In 2002 the Latin American and Caribbean region enjoyed the highest annual per capita consumption of

¹² The FAO definition of fruits and vegetables includes root crops such as potatoes and sweet potatoes. Since these items are almost staples for some countries, the definition overstates the share of the non-staple food.

fruits in the developing world at 102 kilograms per person, the highest meat consumption at 61 kg, and the highest milk and eggs consumption at 113 kg.

The transition towards functional foods with particular nutritional qualities in developed countries also offers an opportunity to farmers in developing countries to enhance their incomes. Many developing countries host vast reservoirs of biodiversity that can be tapped in response to the nutrition transition towards functional foods (World Bank 2006). However, the technology intensity of functional foods remains high and further advancements in biotechnology are likely to extend the reach of consumers for this type of food. The diffusion of such technology to producers in developing countries is currently negligible.

Agricultural production has responded strongly to shifting food consumption patterns, with an increasing share of arable and permanent land used for vegetable and fruit production. Almost all of this increase is occurring in developing countries (Minot and Roy 2006). The share of the arable land used for vegetable and fruit cultivation has remained stable in the developed countries, but has increased markedly in most developing regions as reflected in table 7. The share of land used for cereals and pulses production declined in developed countries and in Latin America, but remained constant or slightly increased in Asia and Africa, implying that fruits and vegetables have replaced other crops. The growth in grain production declined from over 4 percent annually in the 1960s to less than 1 percent in the 1990s. The production of high-value agricultural commodities in contrast has grown between 2 and 5 percent annually over the last 40 years, with the exception of milk, which grew between 1 and 2 percent.¹³

Smallholder production that answers the growing demand for high value food sources may positively affect the producer's consumption by raising income. Although a direct positive relationship between increased income and improved nutritional outcomes is empirically questionable, higher incomes may have important indirect effects. In South and Southeast Asia diversification into high-value food commodities led to the development of innovative supply chains, opening new prospects for augmenting income, generating employment, and promoting exports (Barghouti et al. 2004; Pingali 2004; Deshingkar et al. 2003; Pokharel 2003; Wickramasinghe et al. 2003; Goletti 1999). Food security moreover improved in regions where agricultural diversification took place in favor of horticulture, animal husbandry, and aquaculture (Barghouti et al. 2005; Dorjee et al. 2002).

¹³ The shift in Chinese production has been particularly dramatic. China reduced the share of arable land in cereals by half between 1975 and 2002, while grain productivity almost doubled. The share of land used for fruit production has increased from 2% in late 1970s to 6% in 2002. Similarly, for vegetables, land usage has risen from 3% in mid 1970s to 13% in 2002. China produced 47% of total world vegetables production (in volume terms) in 2002, while its share in fruit production was 15% in 2002.

Table 8: Average Annual Share of Arable and Permanent Land Used for Harvest (%)

Agricultural item and region	1962-71	1972-81	1982-91	1992-2002	1962-2002
Cereals ^a	48.4	49.5	47.6	45.0	47.6
Africa	38.9	37.2	40.0	44.7	40.3
East & Southeast Asia	54.4	55.1	53.8	53.8	54.3
Lat Amer.and Caribbean	35.4	35.1	33.8	29.4	33.3
South Asia	60.2	62.7	63.4	62.2	62.1
Developed countries	43.1	44.8	42.5	38.1	42.0
Pulses ^a	4.8	4.3	4.5	4.5	4.5
Africa	5.9	5.5	5.7	7.9	6.3
East & Southeast Asia	2.2	2.5	2.7	3.6	2.8
Latin America Caribbean	5.7	5.7	6.1	5.0	5.6
South Asia	13.0	12.8	12.9	12.1	12.7
Developed countries	2.0	1.4	1.7	1.4	1.6
Fruits (excluding melons) ^a	1.9	2.2	2.6	3.1	2.5
Africa	3.0	3.5	3.9	4.2	3.7
East & Southeast Asia	2.5	2.8	3.2	3.7	3.1
Latin America Caribbean	2.2	2.7	3.6	4.1	3.2
South Asia	1.1	1.2	1.6	2.1	1.5
Developed countries	1.8	1.9	1.9	1.9	1.9
Vegetables (including melons)	1.7	1.7	2.0	2.6	2.0
Africa	1.4	1.6	1.9	2.2	1.8
East & Southeast Asia	2.8	3.0	3.1	3.4	3.1
Latin America Caribbean	1.2	1.1	1.2	1.3	1.2
South Asia	1.9	2.3	2.7	2.9	2.4
Developed countries	1.2	1.2	1.2	1.2	1.2

Source : FAOStat (2005)

Notes : a. Data corresponds to world average.

Table 9: Worldwide Annual Average Growth in Food Production (%)

	1962-71	1972-81	1982-91	1992-2002	1962-
Cereals (excluding beer)	4.1	2.4	1.5	0.7	2.1
Pulses	0.6	-0.2	2.9	0.4	0.9
Vegetables	1.7	2.7	3.2	5.2	3.2
Fruits	3.4	2.1	1.8	2.8	2.5
Milk (excluding butter) and egg	1.5	1.8	1.4	1.3	1.5
Meat	3.9	2.9	2.9	2.7	3.1
Fish and seafood	5.4	1.4	2.8	2.9	3.0

Source : FAOStat (2005)

Note : Production is measured in metric tones. Vegetables includes root crops such as potatos and cassava. Fish and seafood data pertain to 1962-2001.

From the perspective of poverty reduction, diversifying production towards high value crops is particularly appealing. Most high-value food commodities such as fruits, vegetables, poultry, and fish are labor-intensive, have low gestation periods and generate quick returns. These qualities serve to make them highly suitable for smallholders, representing an often perfect opportunity to utilize their surplus labor and augment their

incomes (Joshi et al. 2004; Barghouti et al. 2005; Weinberger and Lumpkin 2005). Whether a smallholder-dominated economy can actually diversify, and whether smallholders participate substantially in the diversification of production towards high value products is context-specific. A 2006 assessment of diversification towards high value crops in India from the point of view of participating smallholders found evidence that the probability of a household diversifying into vegetable cultivation is higher for smaller farmers (Birtal et al. 2006). Vegetable cultivation was preferred over fruit cultivation, which is generally less labor intensive and more capital intensive (both in terms of start-up and working capital), both of which characteristics are to the disadvantage of small farmers. Families with more members are more tuned to diversifying mainly into vegetables while neither the small farm size nor the size of family impacts diversification into fruits significantly. However, in the case of both fruits and vegetables, the probability of diversifying into fruits and vegetables declines with increase in land sizes. Thus, to the extent that small farmers have been able to diversify and augment their incomes, this is likely to improve nutrition outcomes. Home production of fruits and vegetables are also likely to positively affect nutrition.

The transition towards high value agriculture is however not without constraints, especially for smallholders. When the high-value commodities are products the farmers have not grown before, they will lack information on production methods, marketing opportunities, and the probable distribution of net returns. This problem can be particularly acute when producers have to satisfy highly specific quality and food safety requirements (Minot and Roy 2006). Larger farmers are also often better able to bear the risks associated with producing and marketing high-value commodities. Furthermore, for a small farmer to allocate land to a commercial crop may imply depending on market purchases to meet food requirements, an additional source of risk. Some high value agricultural commodities also require significant investment including the use of specific inputs. Fruit production involves planting trees and waiting 3-5 years for them to begin producing. Farmers in developing countries, particularly poor farmers, often lack the savings or access to credit needed to make these investments. In the case of highly perishable high value commodities, production locations near markets and good marketing infrastructure are particularly important (Torero and Gulati 2004). Small farmers are also less likely to enjoy access to post-harvest technologies. Yet the competitiveness of small farmers relative to large farmers is not fixed and can change over time, usually as a result of changes in physical, human, or social capital. Farmers may acquire new equipment or build physical capital like irrigation works that reduce the cost of production. Farmer's skills and human capital change over time as a result of learning-by-doing, aided in some instances by technical assistance provided by buyers (Minot and Roy 2006).

6: INSTITUTIONAL FRAMEWORKS FOR ACTION IN THE AGRICULTURE SECTOR TO ADDRESS UNDERNUTRITION

The viability of using agricultural interventions to improve human nutrition outcomes has been empirically established by case studies and analyses like those presented in earlier chapters. These provide important precedents with valuable lessons for the planning and design of agricultural programs and interventions. While nutritional status itself is an individual level attribute, the determinants of nutritional status extend far beyond the control of the household of which the individual is a member. Institutions are identified as “basic” determinants of nutritional status in the UNESCO conceptual model presented in chapter 2. Government institutions carry out policies and implement programs that affect nutritional outcomes at the national as well as at the household level. They can therefore be instrumental in ensuring that agricultural programs are effective in meeting national nutritional goals.

Agriculture ministries clearly have a central role to play in scaling up pilot agricultural programs and interventions, but experience has demonstrated the insufficiency of approaching nutrition entirely from the production side. Nutrition is of course also a consumption side issue. Health and education in particular pertain to nutrition in terms of its essential role in human capital and human development. Yet prescribing systematic coordination between different sector institutions as a means of achieving a more comprehensive approach to nutrition is problematic given the bureaucratic barriers that characterize the administrative division of responsibilities and jurisdictions between them.

This chapter examines the administrative barriers that inhibit institutions from organizing and carrying out joint cross-sectoral efforts to improve nutrition outcomes at a national level. It also identifies possible opportunities to work around these barriers to achieve greater impacts that no one sector institution is capable of. Its focus is on government institutions, based on the assumption that governments are chiefly responsible for providing infrastructure, resources, and services to promote and maintain the social and economic welfare of its citizens. The focus on government institutions by no means suggests that non-governmental actors cannot make important contributions to improved nutrition, and these actors can often provide many of the cross-sectoral goods and services the undernourished require. Indeed non-governmental organizations were responsible for the success of a number of nutrition-oriented agricultural interventions reviewed in this report. Detailed analysis of the role of non-governmental organizations is however beyond the scope of this report.

Box 7: Situating Nutrition Administratively within the Public Sector

Within the institutional structure of most states, nutrition rarely stands as a sector on its own, but, reflecting a medical view of malnutrition, typically falls somewhere at lower levels within the organogram of the health ministry, often as a department within the public health sub-sector. Alternatively, more accurately reflecting the multi-sectoral determinants of malnutrition and its significance as a development problem, nutrition may be situated administratively within a coordination body led by a cross-sectorally oriented agency, such as the Prime Minister's Office or Ministries of Finance or Planning. In many countries, such as Nigeria and Mozambique, both of these institutions may be found, with that in the Ministry of Health responsible for implementation of nutrition-related public health activities, while strategic and policy issues are the concern of the nutrition coordination body.

Source: Benson et al. 2004

INSTITUTIONAL BARRIERS TO COORDINATED ACTION IN NUTRITION

The conceptual framework of nutrition determinants is useful in identifying the sector institutions that are directly relevant to improving nutritional status and in mapping their roles in coordinated efforts to address nutrition issues. However, in the details of undertaking these efforts within the bureaucracy of the state, the clarity of the frameworks is often lost as barriers to mounting harmonized efforts across the various sectors of state are encountered.

“Bureaucracy” has long carried negative connotations of inflexible or convoluted procedures that impede rather than facilitate effective collective action. Yet bureaucracies emerged as a generally successful solution to the problem of managing the activities of states and other large organizations, being organized ideally on the basis of clear goals, a rational coordinated functional specialization of sub-units, formal operating procedures, and clear lines of authority. In virtually all countries, the state is organized administratively within a bureaucratic framework of sector ministries, which include separate ministries for health, education, agriculture, and trade. The exercise of political and administrative power follows this framework, and resource allocations, incentives, and systems of accountability are managed accordingly.

The underlying difficulties constraining agriculture and other sectoral institutions from effectively acting in concert to address the problem of undernutrition stem from the nature of the state bureaucracy. Most bureaucracies are not organized in a manner that facilitates broad effective action to address a problem requiring actions across sectors. Even though undernutrition might be the responsibility of the public sector, the sectoral organization of the public bureaucracy clearly hinders undertaking the action necessary.

To identify the bureaucratic elements that were found to impede efforts by the state to address undernutrition in a comprehensive cross-sectoral manner, an institutional study of the linkages between agriculture and nutrition was carried out in Ghana, Mozambique, Nigeria, and Uganda. The Agriculture-Nutrition Advantage (TANA) project is described in box 8. A study of the project identified four particularly important overlapping barriers that prevent the problem of undernutrition from being addressed by the agricultural sector jointly with the health, education and other relevant sectors: the resource allocation and planning processes within the bureaucracy, differing sector mandates and priorities, differing sector worldviews, and capacity constraints for nutritional analysis within sectors.

Box 8: The Institutional Study under The Agriculture-Nutrition Advantage project

The Agriculture-Nutrition Advantage (TANA) project, which ran from 2001 through 2004, aimed to strengthen and expand linkages between nutritionists and agriculturalists, particularly through employing gender sensitive approaches, to reduce hunger and undernutrition in Ghana, Kenya, Mozambique, Nigeria and Uganda. In each country, the project was centered on the activities of national project teams made up of agriculturalists, nutritionists, and gender specialists. The project was implemented by the International Center for Research on Women in partnership with the International Food Policy Research Institute.

The objective of the institutional study under the TANA project was to assess the extent to which the agriculture and nutrition communities in each country work as partners to reduce malnutrition, to gauge the potential gains from increased collaboration, and to understand the various constraints to such collaboration. Principally a qualitative study, the scale of analysis was at the national level in four project countries. Key documents that focused on food, nutrition, agricultural development, and master development planning in each country were reviewed. The documentation obtained before fieldwork began served to guide the broad content of the interviews subsequently carried out. Between 30 and 40 semi-structured interviews with agriculturalists, nutritionists, and policy makers were conducted in each country.

Source: Benson et al. 2004

RESOURCE ALLOCATION AND PLANNING

Resource allocation processes of budgeting and personnel management often make it difficult to mount cross-sectoral action within a state bureaucracy. Like all economic entities, the state functions under conditions of limited resources. Consequently, each sector in seeking to carry out its mandates will compete with other sectors for the resources it requires. Typically, the resource allocation process of government is judged a zero-sum game. For example, a state-level nutritionist interviewed for the study in Nigeria noted that funding is at the core of why there is little interaction between the agriculture and health sectors:

“Everyone wants to be in charge. If [the Health sector] writes proposals that include some agricultural components, [the Agriculture sector] is unhappy with Health, as Agriculture feels that Health is on their turf, taking resources that should be theirs” (Benson forthcoming).

Moreover, if independent assessments are made of how a sector made use of the resources it received, sector-specific criteria are generally used as the criteria. The resource allocation mechanisms provide no incentives for carrying out joint coordinated activities that would achieve a higher level of impact. This being the case, the attainment of nutrition objectives will tend not to be advanced by routine sector planning mechanisms. In this regard, sector wide approaches to planning are likely to make efforts to address undernutrition in a coordinated, cross-sectoral way even more difficult to undertake, as discussed in box 9.

Box 9: Nutrition and Sector-Wide Approaches to Planning

The sector-wide approaches (SWAp) to policy formulation, planning, and implementation that have been promoted in many developing countries in recent years, including in agriculture, tend to work against necessary cross-sectoral efforts to address development problems. Yet, such sector-wide approaches have their own logic of effectiveness and efficiency that is difficult to reject. Thus, in making use of them, explicit recognition of the contributions that the sector concerned can make to addressing cross-sectoral development problems such as undernutrition must be included in the scope of such planning exercises. Otherwise, they are likely to retard rather than foster progress in reducing undernutrition.

SECTOR MANDATES AND PRIORITIES

Formally stated mandates and objectives are important organizing mechanisms for bureaucracies since they help to define courses of action and to distinguish areas of institutional specialization within the bureaucracy as a whole. These proclamations define the scope of action for a sector or institution and serve to identify the particular, unique competencies that the institution will possess to meet those objectives. These priorities also feed back into the planning system as they are the basis by which an institution or sector can make substantive claims on state resources. For the individual civil servant working within the confines of a sector ministry or agency, personal incentives like career advancement tend to revolve around their contribution to that attainment of narrowly sector-specific objectives.

The problem for nutrition as a development priority is that addressing the problem of undernutrition may not be accepted by any one sector as a priority for which it is responsible and towards which it will allocate the resources it controls, including human resources. Particularly as doing so requires engagement with other sectors to address the problem sustainably, there are compelling pragmatic reasons for agricultural and other state institutions to judge that it should not be among their primary concerns. Improved nutrition can be defined among a set of secondary objectives for a sector. However, with multiple objectives, the chances of conflict emerging between the various objectives of a sector are more likely. Some prioritization is required. A senior agricultural researcher in Nigeria noted that agriculturalists have historically been most concerned with raising yields and, secondly, with the profitability of farming. Certainly, they may be willing to take into account nutritional considerations, but at the end of the day, he asserted, increasing crop yields is the principal criterion used to judge the effectiveness of agriculturalists in Nigeria (Benson et al. 2004). Consequently, one generally sees little evidence in the organization of the agricultural sector of any effective attention being paid to what are seen as secondary concerns, such as nutrition. Thomson (1978) notes that most national-level ministries prefer mandates that are entirely within their own sectoral sphere of influence and control. “Such circumscribed objectives are much less time-consuming and much more easily administered; rivalries, jealousies, and frustrations are lessened; and it is more satisfying to the personal ambition of the ministry staff; as credit for success cannot be in dispute and any lack of success is more easily locked away in the ministry’s cupboard.” Attaining

nutrition objectives clearly requires a range of action that is less neatly circumscribed within a single sector.

UNIQUE SECTORAL WORLDVIEWS

The specialized training that sector specialists receive tend to lead to discrete, non-overlapping areas of expertise and qualitatively different worldviews. Knowledge and information that pertains directly to one's own discipline is selectively embraced, while other matters are discarded from consideration as being irrelevant to the attainment of sector objectives. Agriculture sector objectives principally relate to increasing yields, profits, and other benefits that farmers derive as producers. As such, the language and methods that agriculturalists will use, both in technical analyses and in implementation of programs, will be quite different from what are used in other sectors, such as health and education. Nutrition considerations will not fit neatly or completely into the worldview of agriculture or, for that matter, any of the core sectors of government.

The significance of this factor was observed in Mozambique where the Technical Secretariat for Food Security and Nutrition (SETSAN), a cross-sectoral food security and nutrition coordination body for which the Ministry of Agriculture provided secretariat services, was seen by most observers to perform its functions with regard to food security issues reasonably well. However, SETSAN had no nutrition experts among its staff and had not developed a conceptual approach to guide its work in addressing malnutrition in the country. Consequently, in spite of its relative successes in addressing food security issues, because of difficulties in defining how nutritional problems in the country should be addressed, SETSAN was felt to have generally failed to coordinate cross-sectoral efforts to address malnutrition (Benson et al. 2004). The observed lack of cross-sectoral exchange or understanding as a factor impairing action to address undernutrition is not uncommon. The lack of shared perspectives, concepts, and practices frequently results in the various sectors that could work jointly to address undernutrition finding it difficult to find common ground from which to launch such efforts (Maxwell and Conway 2000).

CONSTRAINED CAPACITY FOR NUTRITIONAL ANALYSIS

Identifying the cause of a nutritional problem is central to mounting effective action to address it. Ignorance of what are the determinants of poor nutritional status and an inability to ascertain what resources and actions are needed to sustainably reduce undernutrition in a particular context is part of the explanation for the inability of agriculturalists or specialists in other sectors to address the problem of undernutrition (Gillespie 2001). This was seen in all four countries in which the TANA institutional study was conducted. In Mozambique fewer than a dozen nutritionists have master's level or higher backgrounds. In Nigeria on the other hand, the skills of hundreds of professional nutritionists have not been applied effectively across sectors, and no positive trends in undernutrition are in evidence. In the agricultural sector in all four countries, staff with expertise in nutrition was either absent (Nigeria and Mozambique), withering (Uganda), or relatively isolated within the sector (Ghana) (Benson et al. 2004). Consequently, it is not necessarily surprising that the agriculture sector in each of these countries was seen only to be contributing to improved nutrition indirectly, if at all. Building capacity for nutrition analysis among specialists in other sectors increases the probability that they will recognize the synergies that can be attained by undertaking efforts in concert.

The barriers to the agricultural sector in most developing countries accepting some of the responsibility for the problems of undernutrition in society are quite substantial. Many of these barriers are not perverse, but reflect, first, a rational organization of the state into sectors that enable it to fulfill many of its duties and, second, the fact that nutrition concerns fit poorly within this bureaucratic organization. Barriers also emerge because the areas of expertise, analytical methods, and tools that agriculturalists bring to the tasks with which they are charged are quite different from many of those that are needed to address undernutrition comprehensively. For a broad effort to reduce undernutrition, agriculture will need to overcome the many difficulties of communication and coordination of activities across its sectoral boundaries. In the next section, several approaches by which agriculture could institutionally play a greater role in reducing undernutrition are assessed.

INSTITUTIONAL MECHANISMS TO ENABLE AGRICULTURALISTS TO ADDRESS UNDERNUTRITION

The various institutional barriers that hamper the agriculture sector from acting either alone or with other sectors to effectively and sustainably reduce undernutrition are not easily overcome. Given these constraints, it is unlikely that any single solution to overcoming them can be found in most contexts. Rather, a more opportunistic, incremental approach will likely yield more durable reductions in undernutrition. This section considers several possible components of efforts that the agricultural sector could be a part of or undertake on its own to address undernutrition: multi-sectoral nutrition planning agencies; cross-sectoral issues as policy priorities; the inclusion of nutrition objectives in agricultural activities; the use of NGOs to provide nutrition-related public goods; community-driven development; and including nutrition topics in agricultural training.

Multi-sector nutrition planning agencies

The cross-sectoral nature of the determinants of nutritional status has long been recognized. A common approach in grappling with the problems of mounting necessary action to address undernutrition across disparate sectors has been to establish national multi-sectoral nutrition planning agencies to ensure that coordinated efforts are undertaken. However, of the many such agencies that were set up in the 1960s and 1970s, few catalyzed substantial reductions in malnutrition. Without any real authority over the range of sectors involved, they proved ineffective in coordinating efforts across these sectors. Moreover, as the political leaders who championed their formation turned their attention to other issues, the material commitment of government to address malnutrition dwindled, and the agencies were starved of operational resources. Consequently, in the following decades, coordinated cross-sectoral programs to reduce malnutrition in many countries were replaced by sector-specific projects focused primarily on technical nutrition interventions (Levinson 2000).

Such multi-sectoral coordination agencies remain a common feature of national strategies to address undernutrition. Few of these agencies established in recent years demonstrate any greater success than those created 30 to 40 years ago. Mozambique, Nigeria, and Uganda have established such agencies over the last five to ten years, with no evidence of greater or more effective impacts on malnutrition than in Ghana, where no such agency is in place (Benson forthcoming). The challenges of cross-sectoral coordination remain as daunting now as they were in the past, with agencies generally

lacking adequate authority or resources to introduce incentives to compel cross-sector coordination.

In reflecting on why many such attempts at coordinating efforts to address undernutrition have been unsuccessful, a clear problem relates to the scope of action of these agencies. The agencies frequently have been too involved in implementation, particularly when they have insufficient authority to direct how the sectors concerned actually go about their tasks. Heaver (2005) suggests that a better arrangement would be to allow the sectors the latitude and resources to carry out their own programs, with the nutrition coordination agency being granted the necessary authority to define overall policies and strategies and to guide the allocation of resources. Government should make use of the existing sectoral infrastructure to implement programs, however imperfect it may be, and build on what is already in place (Kennedy 1994). A lesson that seems to have been widely recognized, if not widely learned, is to “plan multi-sectorally, but implement sectorally” (Maxwell & Conway 2000).

As such, multi-sectoral coordination agencies have a place in the implementation of government strategies to sustainably reduce levels of undernutrition. With sufficient authority and resources, cross-sectoral coordination bodies can ensure that proper incentives – both positive and negative – are introduced to motivate sector institutions to prioritize activities and allocate resources targeting improved nutrition outcomes. Cross-sectoral nutrition coordination bodies can operate the accountability mechanisms needed to ensure that sector agencies carry out their mandated nutrition-related activities in alignment with broader government strategies to address malnutrition. Moreover, such agencies should be expected to continually engage in relevant national and sectoral policy processes, including in agriculture, to ensure that undernutrition continues to be viewed by political leaders and sector managers as a development priority (World Bank 2006).

Cross-sector issues as policy priorities

In a normative sense, formal policies define in quite explicit terms what is considered the common good for the citizens of a nation and serve as statements of how government intends to prioritize its actions and its expenditures. Formal statements of policy are arguably more important for defining priorities when related to issues that fall outside of sector-specific interests like nutrition issues. Whereas sector-specific mandates and worldviews serve to motivate action to address issues that fall within the competencies of a single sector, such incentives are absent for cross-sectoral issues. Making it clear that the priorities of government include mounting effective action to reduce undernutrition is one way in which sector priorities can be swayed towards paying closer attention to the needs of the undernourished. Public resource allocations to the agriculture sector may be made contingent on how much the sector has contributed and plans to contribute to the attainment of broader development objectives such as those articulated in a master development plan or a Poverty Reduction Strategy. This can provide stronger incentives are put in place for agriculturalists to formulate work plans that go beyond their traditional narrow sectoral objectives. With this objective in mind, Ugandan nutritionists participated effectively in 2004 in the revision of the Poverty Eradication Action Plan, the government’s master development strategy, resulting in heightened attention to undernutrition within this broader policy (Benson et al. 2004). However, follow-up research is needed to determine whether the increased emphasis on nutrition in this policy

actually has led to increased attention to the problem of undernutrition in the annual work plans of the various state sectors in Uganda or in the allocation of resources to attain improved nutrition objectives.

For such high-level policy statements to influence sectoral efforts to address undernutrition, sustained interest by political leaders in attaining improved nutritional outcomes is required. Political champions for the attainment of improved nutrition are needed; individuals who are politically well-connected, persistent in character, and have access to many of the multiple arenas and institutional venues in which policy debates are undertaken. Such champions have been shown to be a key element in several instances in which significant changes were brought about in the priority given to state efforts to combat undernutrition (Rokx 2000). Similarly, international donors can provide important incentives by providing funding and capacity building opportunities to agencies in the agricultural sector or other sectors so that they can work towards reducing the numbers of the undernourished in a country or area. However, if implemented in a one-off fashion, the sustainability of such changes is open to question (Winikoff 1978). If attention to undernutrition enjoyed a high profile in national policy process or in donor priorities, subsequent changes in leadership of government or of donor organizations often results in a more muted profile for nutrition as a development objective. Continual strategic advocacy for nutrition action thus becomes an important element if agriculture and other sectors are to undertake actions at a level and for a length of time sufficient to bring about substantive reductions in the numbers of undernourished in the population.

Nutrition objectives for agricultural activities

Activities with clear nutrition implications within the agricultural sector have been the focus of much of the technical content of this report. These include the production and consumption of staple food crops, fruits and vegetables, and animal products that are rich in micronutrients or otherwise contribute to a high quality diet and the use of agricultural communication channels to enhance nutritional knowledge within farming households. Although their success in contributing to improved nutritional outcomes varies depending on the pathways by which the desired nutritional effects are obtained, such activities do compel their implementers within the agricultural sector to undertake nutritional analyses to identify the nutritionally vulnerable within the population in which they work and to diagnose the causes of that malnutrition. Such analyses, if conducted in an informed manner, will highlight the important contribution that agricultural initiatives can make in assisting the undernourished, the need for complementary action on the part of other sectors, and the importance of improved nutrition as an input to a more productive agricultural sector. With sufficient political support, initial efforts by agriculturalists to contribute to improved nutrition should increase in scope and complexity as the determinants of improved nutrition are increasingly made clear to those involved through practice. The nutrition objectives of agricultural activities can foster a more holistic vision of what is needed across the various public sectors to sustainably improve nutrition. However, progress in this regard is not assured, as the example in box 10 shows.

Box 10: Home Economists as Agricultural Extension Agents

Progressive increased attention to nutrition within agriculture is not assured. Agricultural extension services offer a case in point. Such services provide a channel for reaching rural smallholder households with information on how they might provide better care to their nutritionally vulnerable members. In the 1970s and 1980s, recognizing this, many extension services in sub-Saharan Africa, including Ghana and Uganda, included among their field workers home economists, most of whom were women. Their function was primarily to work with women in farming households on both production and consumption issues, including nutrition. However, over the past twenty years most extension services have been reorganized, including through programs of ‘professionalization’ whereby field extension agents had to meet minimum professional qualifications to be retained in the service. As these qualifications primarily were agricultural production oriented, most home economists were eliminated from extension services.

Moreover, the service has also become more male dominated as a result. This is due to gender sorting in school where boys are more likely than girls to follow the natural sciences focused course of study necessary to attain professional qualifications in agriculture. Several important determinants of nutritional status have strongly gendered characteristics, particularly breastfeeding, weaning, child care, and meal preparation. Consequently, although information on such nutrition concerns may still feature among that information extension agents offer to farming households, male extension agents are a poor choice as messenger on these topics. We should expect that the level and quality of knowledge on nutrition obtained by farming households from extension agents certainly has not improved with the restructuring of extension services.

Source: Benson et al. 2004

Community-driven development

Community-directed efforts also can provide important incentives for agriculturalists to contribute to efforts to reduce undernutrition, often working in concert with other sectors. Community-driven development (CDD) gives control of many local development activities to those who will be most affected by them, the local residents (Dongier et al. 2003). When governments support such efforts, they usually also commit to contributing state resources and expertise to the community as its members work to realize their development ambitions. Communities though are unlikely to prioritize their development needs neatly according to unique sectoral competencies (Mason 2000). This being the case, community expectations that state agencies will assist them in addressing a problem requiring contributions from multiple sectors, such as undernutrition, provide important incentives for cross-sectoral action to be undertaken. Where governments are strongly committed to supporting community-driven efforts, there may be sufficient incentives for cross-sectoral activities to flourish in spite of the bureaucratic organization of the sectors. For example, community nutrition programs that involve cross-sectoral teams from government agencies in providing community facilitation services have led to substantial reductions in undernutrition in several Asian countries (Tontisirin and Gillespie 1999).

Moreover, the local scale at which action will be taken by the agents of the various public sectors concerned also may enable such action to be performed more easily. The resource conflicts between sectors that were noted as constraining cross-sectoral undertakings typically play out at the national level in most countries. At more local levels, civil servants may have limited control over sector resource allocations. However, the ability of state agencies to work collaboratively in assisting communities will vary on a

case-by-case basis. In both Ghana and Uganda, countries in which the decentralization of state functions has progressed to a greater extent than in most other African countries, district level agriculturalists stated that local concerns were not necessarily more important than sectoral concerns in guiding their actions (Benson et al. 2004). These agriculturalists were still subordinate to sectoral superiors, they operated with limited resources, and many of the incentives that motivated their individual efforts hampered rather than fostered cross-sectoral action to assist communities. Consequently, while community-driven development may promote increased attention from agriculturalists to local nutrition problem, there is no guarantee that it will do so.

Nutrition in agricultural training

As was shown earlier in the review chapters, agriculture may provide important elements necessary for sustained improvements to nutritional status in specific contexts, particularly among farming populations. If improving nutrition is a high priority development objective of government, attaining that objective will require a more sophisticated understanding of the determinants of improved nutrition by professionals in the public sectors concerned. Providing training in human nutrition to agriculturalists is an important component of this. Whatever the sector or sectors, “the choice of the most appropriate intervention will depend on who is malnourished and why (Kennedy 1994).” Providing training in nutritional analysis will make it more likely that that agricultural projects and programs that seek to improve the nutritional status of the target population will be based on a clear conceptual and analytical framework for how the nutritional goals will be attained. Similarly, it will also allow for better identification and understanding of the needs of the undernourished that the agricultural sector can assist in meeting and enable better monitoring of project performance in meeting those needs. However, few countries, if any, now require that their agricultural trainees acquire a basic understanding of the determinants of improved nutrition.

CONCLUSIONS

The institutional barriers that agriculturalists, particularly those in the public sector, face in trying to mount effective action to assist the undernourished are durable and strong. The fact that the organization of these institutions is relatively ineffective for addressing the problem of undernutrition in society is unlikely to be sufficiently compelling to cause these institutional structures or the manner in which they operate to change. Consequently, while strong action by the agricultural sector or broad coordinated action by several sectors may logically appear to be required to reduce levels of undernutrition, in practice, an opportunistic approach may be more effective. Such a strategy would use existing individual activities in the agricultural sector and in other sectors in an instrumental way to address important context-specific determinants of undernutrition. Working in this incremental manner appears more likely to be successful than mounting a large-scale cross-sectoral effort that is a poor match for the institutional framework within which it would be implemented (Lynch 1979). Experience from many cross-sectoral efforts, focused on both nutrition and other problems, demonstrates that there is considerable merit in being task or problem oriented, starting small, achieving short-term goals, and building on these successes iteratively to address larger problems (Maxwell and Conway 2000).

Coordinated cross-sectoral efforts may be necessary to sustainably reduce undernutrition. However, given the past failure of such efforts, new initiatives should first be piloted before being scaled up, particularly in those institutional environments where bureaucratic structures and processes are rigid. In such cases, “contrary to logical argument, the complex etiology of malnutrition does not necessarily demand a complex response” (Ross and Posanai, cited in Levinson 1995). Individual sectoral responses will often be the best that can be realistically expected. No nutrition program at the outset should be dependent for its success on inter-sectoral coordination. The risk that such coordination is not going to happen is too great (Levinson 1995). Where cross-sectoral action is required, alternative partners to other sectors within the state bureaucracy, such as NGOs, may offer greater potential for success. However, simply ensuring that the agriculture sector or, for that matter, any other sector with a role to play in improving nutrition takes that role seriously is an important first step. Coordinated efforts should only follow once such commitments are clear.

Moreover, the causes of undernutrition are context-specific. Agriculturalists need to be clear about what they can contribute in resolving malnutrition in a particular context. Having this clear understanding not only guides program design, but it also enables agriculturalists to evaluate whether other means than agriculture might be more efficient in attaining specific goals of nutritional improvement. There are likely to be significant opportunity costs associated with agriculturalists devoting their energies towards nutrition objectives (Pinstrup-Andersen 1982). These costs need to be evaluated. Consequently, capacity for nutrition analysis is critical to any planning by agriculturalists to address aspects of the problem of undernutrition.

In effect, the undernourished can improve their nutritional status through agricultural means. There are many good reasons for providing incentives to agriculturalists to address problems of undernutrition in a dedicated manner. However, Levinson (1995) suggests that the reverse relationship is also important. “Increased agricultural production per se is insufficient if that production does not address hunger and malnutrition through its production or consumption effects.” Attention to the nutrition benefits to which agriculture can contribute forces the sector to consider more rigorously who benefits from increased agricultural productivity, and to change its priorities and activities where necessary in light of these considerations.

CHAPTER 7: CONCLUSIONS AND NEXT STEPS

Agriculture carries enormous potential to contribute to improved nutritional outcomes and agricultural programs should include such outcomes among their objectives. The experience of agricultural programs which have done so points to a number of general but meaningful lessons. The very inclusion of nutritional objectives by these programs reflects an implicit recognition that investing in agricultural production and growth do not necessarily result in improved nutrition. Nor do improved nutrition outcomes flow automatically from increased agricultural production, lower food prices, or higher incomes. While these pathways may be instrumental in satisfying a number of necessary conditions to improved nutrition, they do not in themselves provide sufficient condition. The persistence of malnutrition despite the generally overwhelming success of food production belies any notion that the solution to adverse nutrition outcomes is attainable through the production side alone. Nutritional criteria have to be explicitly incorporated into the design of agricultural programs if nutritional objectives are embraced, and if food production is to effectively answer the demand for foods with particular nutritional qualities. This represents both a challenge and an opportunity for agriculture and its major actors.

Incorporating non-agricultural criteria like health and nutrition into the design and conduct of agricultural programs suggests developing an effective interface between agricultural and other institutions. Yet systematic high-level coordination between different sector ministries does not appear to be plausible given the bureaucratic barriers that divide them. The report therefore examined alternative approaches to formulating a more comprehensive approach to improving nutrition as a development objective. The prominence of nutrition as a policy priority in national development plans and poverty reduction strategies may be a useful starting point. At this level, nutritional objectives transcend the administrative divisions between government sector institutions while still requiring the respective contributions of individual sector institutions. Those institutions may find and capitalize on opportunities to work together, but their effective inputs are not contingent on such active collaboration coming to pass. In this light, programs and policies can be planned multi-sectorally, yet carried out sectorally. Insofar as sector institutions are held accountable for their performance in carrying out their separate mandated nutrition-related activities, their effectiveness may be incentivized. Sector ministries compete for limited government resources. If their budgetary allocations are made contingent on their contribution to reducing malnutrition as a national policy precedence, their effectiveness in that role is more likely to become an institutional priority. Similarly, international donors can provide important incentives by offering funding and capacity building opportunities to agencies in the agricultural sector or other sectors so that they can work towards reducing the numbers of the undernourished in a country or area. To improve the chances of this happening, agricultural institutions should develop the internal capacity to carry out analyses of the nutritional implications of the programs they plan.

The contexts in which agricultural programs are implemented are shifting as incomes rise, new technologies are introduced, food marketing systems expand, and policies and food consumption patterns change. These changes present planners with a moving target in tailoring programs to fit local realities. They also present practitioners and policy makers

with new factors to consider as they seek to replicate successful experiences across localities and scale them up to provincial and national levels.

Help poor producers respond to changing food consumption patterns. Anticipating and responding to changing demand is a vital imperative for farmers in general, but among poor farmers in developing countries the stakes are particularly high. A significant part of their production is intended for their household's own consumption, and therefore much of the demand they are satisfying is their own. With respect to the proportion of food they produce for market, increasing demand for high value food sources represent an important opportunity to earn more income. Yet switching to new and unfamiliar crops and producing for foreign markets with stringent food quality and safety requirements is also fraught with risk, and both opportunities and risks need to be addressed by agricultural programs. Some of these risks may be offset by farmers' participation in large, often supermarket-led supply chains. In many cases these supply chains provide farmers private extension services that are used to build extensive networks of reliable suppliers. Arrangements like contract farming enable farmers to link their production with these chains, and may come to represent important opportunities for public-private partnerships.

Agricultural programs and interventions carried out at the level of local communities were the focus of the empirical evidence presented in this report. The importance of designing programs that accommodate prevailing agricultural and nutritional conditions entails developing a sound understanding of producers' priorities, incentives, assets, vulnerabilities, and livelihood strategies. This is all-too-familiar to agricultural planners, and can be said of virtually any agricultural intervention. The need to evaluate and target major nutritional problems experienced by the community in program design is less familiar, but is an essential requirement for any agricultural intervention with nutrition-related objectives. Understanding the motives and constraints that affect household consumption decisions is in this sense no less important than understanding those that affect production decisions. Many of these factors relate to household economics and to local understandings of socioeconomic realities. Some however are attributable to cultural norms that in and of themselves have little if anything to do with economics – but that may bear heavily on the rationales behind households' economic decisions and processes. They may outright determine which household members maintain control over which household resources, and may influence such nutritionally-vital decisions as the allocation of different quantities and types of food among household members. From this angle women emerge as vitally important agents, both in their roles as producers and as custodians of household welfare. Their importance moreover generally increases in the lowest-income settings and among households with high dependency ratios – where a large proportion of household members are non-producing, nutritionally-vulnerable dependents.

Enabling and empowering women. The resources and income flows that women control wield disproportionately positive impacts on household health and nutrition outcomes. Particularly in rural areas they also tend to lack access to economic opportunities outside the domestic sphere to which traditional customs often confine them. They are also very often severely constrained by time, and the multiple roles they play as producers and caregivers. Agricultural programs and policies that empower and enable women, and that involve them in decisions and activities throughout the life of the program achieve greater impacts on nutrition outcomes. These programs increase women's control over income and

other productive resources by targeting them in their roles as economic agents and stewards of household food security and health.

Women's access to services is important as well as their access to income and productive resources. Educating women on agriculture-health links is an especially effective means of improving household nutrition. Health information services provide a potent means of changing behaviors to reduce the high levels of childhood morbidity that are associated with inappropriate feeding practices, premature weaning, and child care generally. Providing households with health information about sanitary food preparation and water use, and the prevention of infectious and food-borne diseases can dramatically improve nutrition outcomes – particularly with respect to those diarrheal illnesses that disproportionately afflict children. Agricultural extension services and public information campaigns such as those dealing with integrated pest management are also important vehicles for conveying health-related information.

Outreach and behavior change. Whether regarded as a resource or a service, the value of information that is directed at behavior change among farmers and consumers presents itself as a salient conclusion of this report. Those who are armed with information and knowledge about the nutritional significance of the foods they produce and eat are able to make better production and consumption decisions. Nutrition-related education and communication strategies may offer instruction on food preparation and safety, childcare and feeding practices, and the nutritional qualities of different foods – such as those fruits, vegetables, and animal source foods featured in the interventions described in chapters three and four. Here too, targeting women with health and nutrition information is likely to have still greater catalytic effect, given their typically closer affiliation with the household. A woman armed with information that enables her to recognize the symptoms of a vitamin A deficiency is better placed to make an appropriate dietary adjustment – especially when she has participated in an agricultural program involving a food source that can be applied to that nutrient deficiency. A woman equipped with knowledge that enables her to recognize a particular medical condition is likewise by definition better placed to treat it, or to know when the affected family member should be taken to a health service provider.

Information is something that is required from households and communities as well as something to be made available to them. The subjective economic, social, and cultural reasons that underlie household production and consumption decisions are largely inaccessible to program personnel from outside the participating community. Indigenous knowledge and livelihood strategies are very often unspoken, and may encompass local understanding of opportunities and risks that carry important practical merit not obvious to the outside observer. In areas in which community-based, local civil society or non-governmental organizations are active, they may represent important sources of information on local perspectives, and present agricultural programs with valuable partnerships with which to engage local communities. Community-based organizations are embedded in situ within target communities and represent important reservoirs of social capital where community members make collective decisions about how local resources are to be used and how livelihoods are to be advanced. Other organizations that have operated for years in local communities often establish relationships of intimate trust and rapport with their contacts in local communities, and listen to local concerns and advise on possible resolutions. These can be conduits of two-way information flows between program administrators and community members, and are often well-situated to serve as

agents in monitoring and evaluation. Local organizations are moreover often relatively free of the stark sectoral divisions of higher level bureaucracies, and may employ agriculturists and health and nutrition experts who are well aware of each other's activities, concerns, and priorities.

Next Steps. There are a number of important issues that are not covered in this paper that deserve separate investigation and analysis. The effects of climate change and the implications of agricultural production shifting from food products to biofuels are matters of serious concern for food security and nutrition. Analysis of their potential impacts on food production and prices suggests itself as an important object of future research.

This report consisted mainly of a review of empirical evidence about past and ongoing cases of agricultural interventions with nutrition-related objectives, and more broadly about connections between agricultural production and nutrition. Its analysis of the practical implications of these lessons shed light on the dynamics and causal relations that agricultural practitioners should take into account when planning programs or providing policy advice that focus the crosshairs of production goals onto a nutrition-related target or targets. There is by now good reason to anticipate that nutritional aims will come to play more prominently in the calculus by which the value of agricultural programs is rated. The expository account offered in this report hopefully lays the groundwork for more practical work in which the details of applying these lessons operationally can be prescribed.

APPENDIX

METHODOLOGY USED IN CHAPTER 3 (STAPLES)

The following searches were carried out for the purposes of the literature review.

1. The most recently published review (Berti et al., 2004) employed a documented search strategy with search date of November, 2001. We repeated their search to cover the years 2001-2007, with slight modifications to their search terms (below). We searched in PubMed and in Science Citation Index Expanded and Social Sciences Citation Index (latter two via Web of Science). This search was very broad and yielded approximately 1700 items indexed in Medline and approximately 1800 items indexed in Web of Science.

(agricult* OR 'sustainable development' OR 'rural development' OR 'food production' OR farm*) AND (nutriti* OR anthropom* OR diet* OR 'child growth')

Search limits also excluded studies with animals as subjects; search date March, 2007.

2. In addition, to ensure that no relevant studies were missed, we supplemented with Medline searches using the following terms:

nutriti* AND agriculture AND (trial OR interve* OR effect* or effic* OR program OR policy)

“food security” AND agriculture AND (trial OR interve* OR effect* or effic* OR program OR policy)

These latter two searches yielded 105 items and overlapped with the broader searches.

3. Third, we searched forward (Web of Science cited reference search) from three previous reviews (Kennedy et al., 1992; DeWalt, 1993; Berti, 2004) and evaluated resulting studies for relevance.
4. In addition, during February, 2007, a number of web sites were searched for project results papers, including:

Bioversity International (formerly the International Plant Genetic Research Institute and the International Network for the Improvement of Banana and Plantain):

<http://www.bioversityinternational.org/>

Collaborative Crop Research Program:

<http://mcknight.ccrp.cornell.edu/projects/nutrition.html>

Food and Agriculture Organization:

<http://www.fao.org/documents/>

HarvestPlus Program:

<http://www.harvestplus.org/>

Healthbridge Canada (formerly Programme for Appropriate Technology in Health, Canada):

http://www.healthbridge.ca/foodandnutrition_e.cfm

International Center for Research on Women:

<http://www.icrw.org/>

International Food Policy Research Institute:

<http://www.ifpri.org/>

International Fund for Agricultural Development:

<http://www.ifad.org/>

Michigan State University, Towards Sustainable Nutrition Improvement Project

<http://www.aec.msu.edu/fs2/tsni/index.htm>

Methodology used in Chapter 4 (Fruits and vegetables)

Databases:

A structured electronic search of the PubMed database was conducted. It included publications from 1980 to January 2007. Other limits included human studies, in the following languages: English, French, Italian and Spanish. Significant efforts were also made to identify other studies through searches in the “grey literature” by accessing relevant websites. In addition, a number of experts from various international organizations were contacted through e-mail to ask for copies of reports documenting their experiences. The obtained reports were included in this review. Additional publications were obtained by going through the references of the retained publications to identify those that were relevant for this topic. Finally a number of articles and reports were obtained from colleagues who already had a number of articles available that had been compiled for prior reviews.

Search Terms:

After extensive testing, the following string of search terms proved the most effective in identifying the relevant literature::

("Nutrition Disorders"[MeSH] OR "Nutritional Status"[MeSH]) AND ("Agriculture"[MeSH] OR Horticulture OR Garden) AND ("Nutrition Assessment"[MeSH] OR Dietary Guideline OR School-based intervention OR Program OR Intervention OR Promotion OR Policy OR Nutrition Education OR Prevention OR "Education"[MeSH] OR "Behavior"[MeSH] OR "Marketing"[MeSH] OR Mass-media OR "Schools"[MeSH] OR "Communication"[MeSH] OR "Intervention Studies"[MeSH] OR "Public Policy"[MeSH] OR "Randomized Controlled Trials"[MeSH] OR "Health Education"[MeSH] OR "Government Programs"[MeSH] OR "National Health Programs"[MeSH] OR "Health Promotion"[MeSH] OR "Nutrition Policy"[MeSH] OR "prevention and control"[Subheading] OR "Guidelines"[MeSH] OR Impact OR Efficacy OR Effectiv*

- **Inclusion/exclusion criteria:** Only high quality studies were included i.e. those with an experimental or quasi-experimental design for which the intervention was clearly described, and include tests of statistical significance in the impact analysis.

Searches:

The PubMed search using the search string listed above resulted in a total of 188 articles. All were subjected to a title and abstract scan for relevance and a total of 72 were found to be relevant. They were evaluated in more detail and a total of 26 of these articles were obtained in full-paper form for inclusion in this document. It should be noted that several of these papers were background or historic documents that did not report on a specific intervention.

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